MARCH 6, 1958

MACHINE DESIGN

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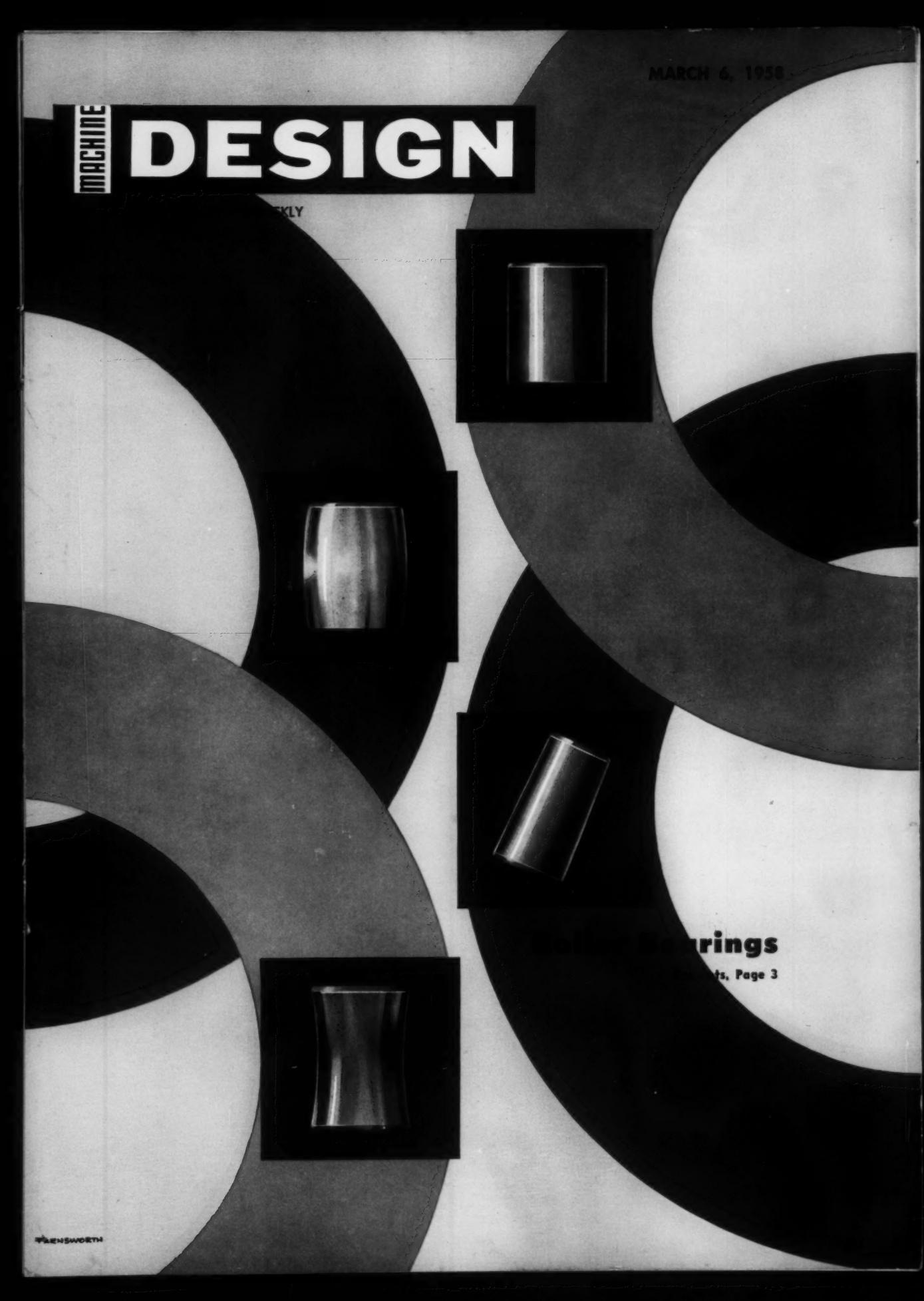

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...ts, Page 3

WENSWORTH

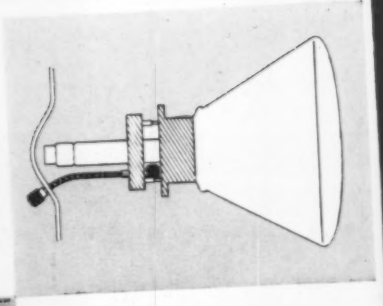
S. S. White

Flexible Shafts Simplify Product Design

The designer of this TV set used S. S. WHITE Flexible Shafts to avoid the many restrictions which a rigid connection would have imposed on his design.

Whether your product is in the design stage . . . or in full production, S. S. WHITE Flexible Shafts may be the simple, economical road to improvement. Power sources, driven members, controlled parts and their controls can be positioned to better advantage. Alignment problems, costly methods of connection and adapting can be eliminated. The number of parts required for control and power drive can be reduced, thus reducing assembly time and cost.

Our engineers will be glad to give you their help in selecting and applying the flexible shaft that will do the best job for you. For full information, just write to



S. S. White

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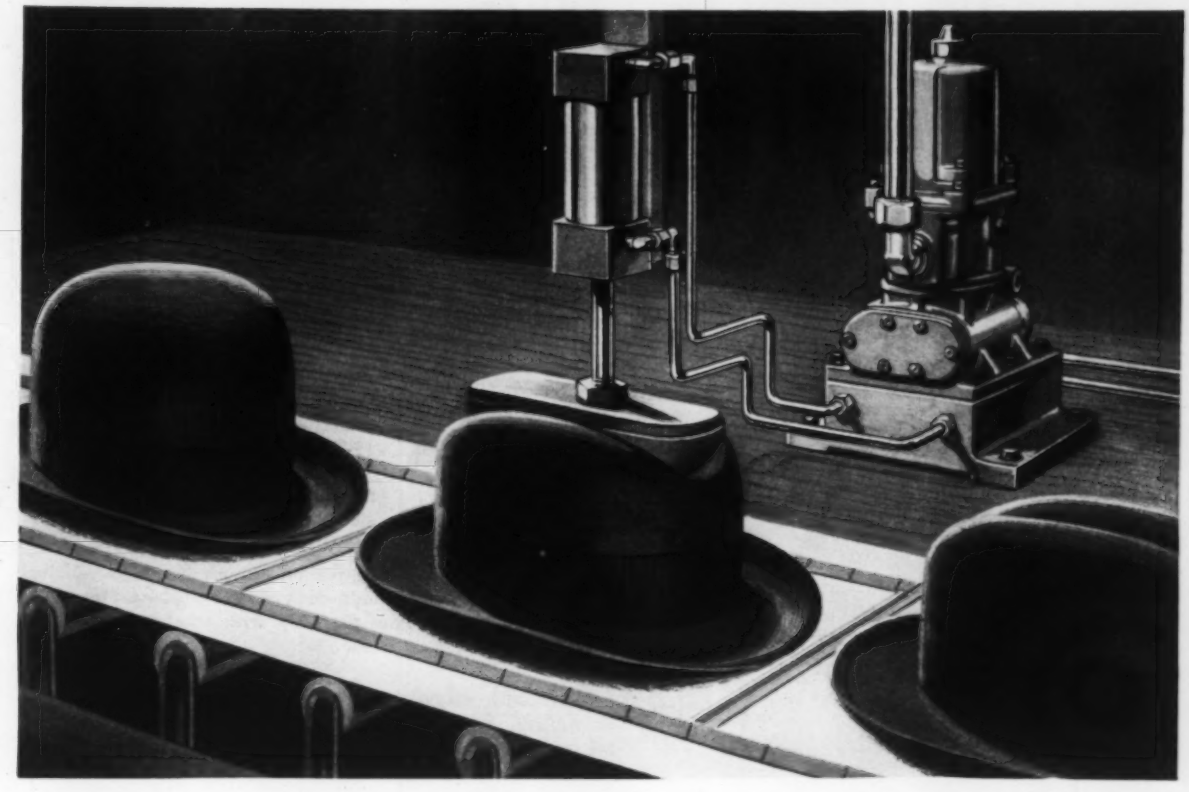
USEFUL DATA on how to select and apply flexible shafts! Write for Bulletin 5601.

S. S. White Industrial Division, Dept. 4, 10 East 40th St., New York 16, N. Y. Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.

Circle 401 on Page 19

What? A Homburg Dimpler!

Unlikely?...Yes, but...

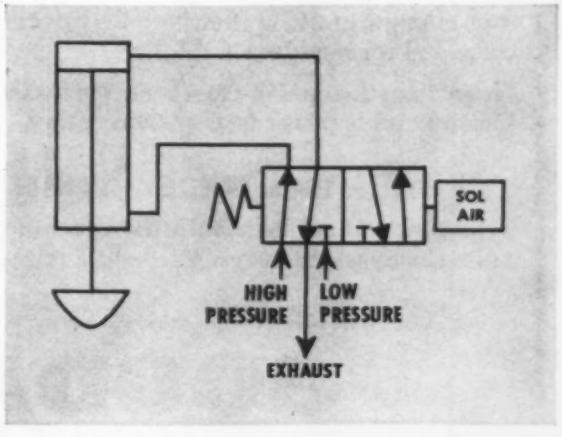


Unlikely? Yes—most men will continue to give the top of their pet fedora a "just-right" push of the fist when they buy it back from the hat check girl. But this little flight into fancy does give us a chance to show a cylinder with a split personality . . . able to advance softly, then retreat quickly to get the next hat into position without waste of time. It's made possible with a Ross 4-way, 5-port valve that provides a *different* pressure for each side of the cylinder.

Maybe you have a serious problem that the Ross 4-way, 5-port valve can solve

The same idea of cylinder advance and retreat is put to very real and valuable use in many machines today. Perhaps you, too, have an application where *one* valve controlling *two* pressures will cut production costs. Contact your nearby Ross Service Engineer or write us for details on the 4-way, 5-port valve.

Combining engineering with ingenuity for better air control



1. Solenoid is energized, creaser descends slowly.
2. Solenoid is de-energized, creaser rises quickly.

ROSS OPERATING VALVE CO.
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Circle 404 on Page 19

What makes

V-Belts with the Green Seal

your best belt buy—

by far

A Special tension members of steel cable or exclusive, synthetic Triple-Tempered (3-T) Cords—carefully tempered with Tension, Temperature and Time for maximum strength with minimum stretch.

B Tension and compression sections of mildew-inhibited rubber compounds—designed to the job—and manufactured to team perfectly with whatever type load-carriers are used.

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—SO NEXT TIME YOU NEED V-BELTS

— be sure you get belts with the Green Seal. See your Goodyear Distributor for details. Or write Goodyear, Industrial Products Division, Lincoln 2, Nebraska, or Akron 16, Ohio.

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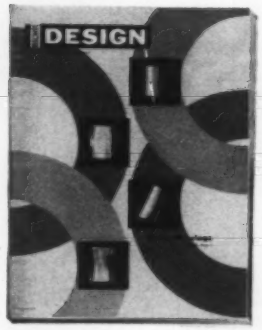

Front Cover: Four basic types of roller bearings—cylindrical, tapered, and concave and convex self-aligning—are featured on George Farnsworth's cover to highlight Johnny Riddle's article on Page 138.

March 6, 1958

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March 6, 1958

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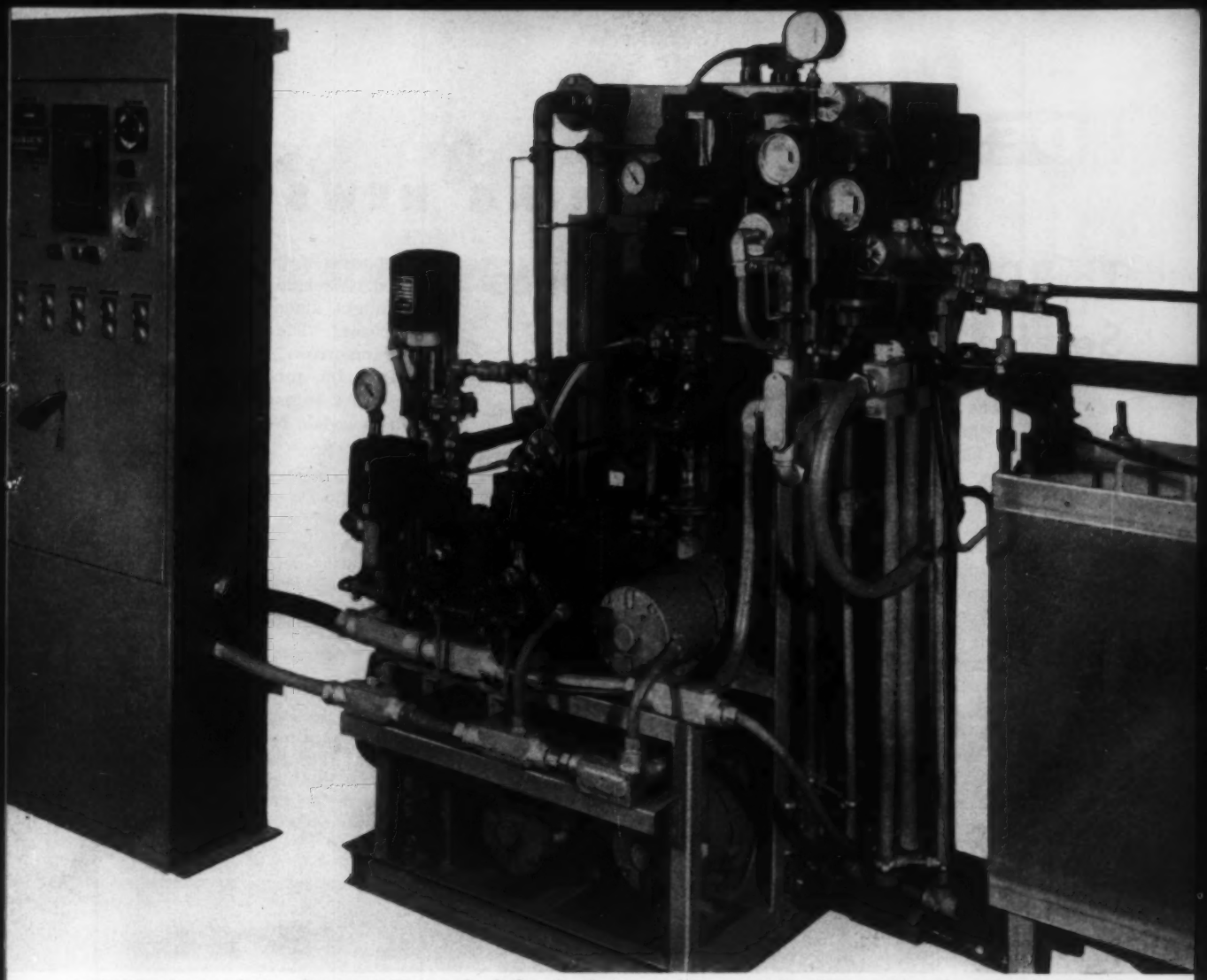

AN IONICS salt-water demineralizing unit. Water is desalted on the electric membrane principle—where positive and negative charged sodium and chloride ions are selectively removed from the water molecules. Note the black and gray Sealtite—from ½" to 1¼"—used here!

In remote, vital areas—Ionics demineralizers depend on Sealtite for failure-proof conduit!

More than 20 Ionics water desalting plants are now installed in water-short areas of the Middle East and United States. Units serve on radar warning platforms off our coasts.

Here—where down-time would not only be costly, but a possible major catastrophe—the electrical wiring is protected with Sealtite* flexible, liquid-tight conduit!

Sealtite takes up flexing and vibration, will not crack or break. It simplifies installation—particularly in tight quarters or where there are misaligned outlets. And its tough plastic jacket shrugs off weather, moisture, oils, and all common chemicals.

WANT TO KNOW MORE? Electrical Wholesalers stock Types U.A. and E.F.† Sealtite in easy-to-handle cartons or on reels in gray and black. Be certain you ask for and get the quality conduit marked "Sealtite" on the cover. Buy it in long lengths and cut it on the job without waste. Your wholesaler also stocks liquid-tight connectors. Free Booklet S-538 gives you full information on Sealtite. For your copy, write: The American Brass Company, American Metal Hose Division, Waterbury 20, Conn. In Canada, Sealtite is approved by Canadian Standards Association, and sold by Anaconda American Brass Ltd., New Toronto, Ont. 37185

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CUTAWAY SECTION of Type U.A. Sealtite shows tough polyvinyl jacket over flexible metal core. Copper conductor wound spirally inside conduit gives positive ground.

Insist on the conduit marked **SEALTITE**

FLEXIBLE, LIQUID-TIGHT CONDUIT

an **ANACONDA®** *product*

Circle 406 on Page 19

Top Design Show-Conference Set for Chicago April 14-17

NEW YORK—The year's top exposition for design engineers, the 1958 Design Engineering Show and Conference, will open in Chicago's International Amphitheatre on April 14 for a four-day stay. The concurrent show and conference, produced for the first time in 1956, have grown to one of the largest industrial expositions in the country.

This year's show will have an exhibit area more than four times the size of the first show, with more than 400 companies as exhibitors, and more than 20,000 visitors expected. Visitors are invited to bring specific problems with them in the form of sketches, requirements, or questions to be worked out with the help of "hundreds of specialized technical experts" at the show.

Dr. J. T. Rettaliata, president of the Illinois Institute of Technology, will address a luncheon scheduled for April 15.

The conference features noted design leaders in a panel on *Putting the Design into Production* on April 14 and a general engineering session on April 17. Separate conference sessions on mechanical, power and control, and materials problems on April 15 and 16 will permit guests to choose technical sessions of most interest to them.

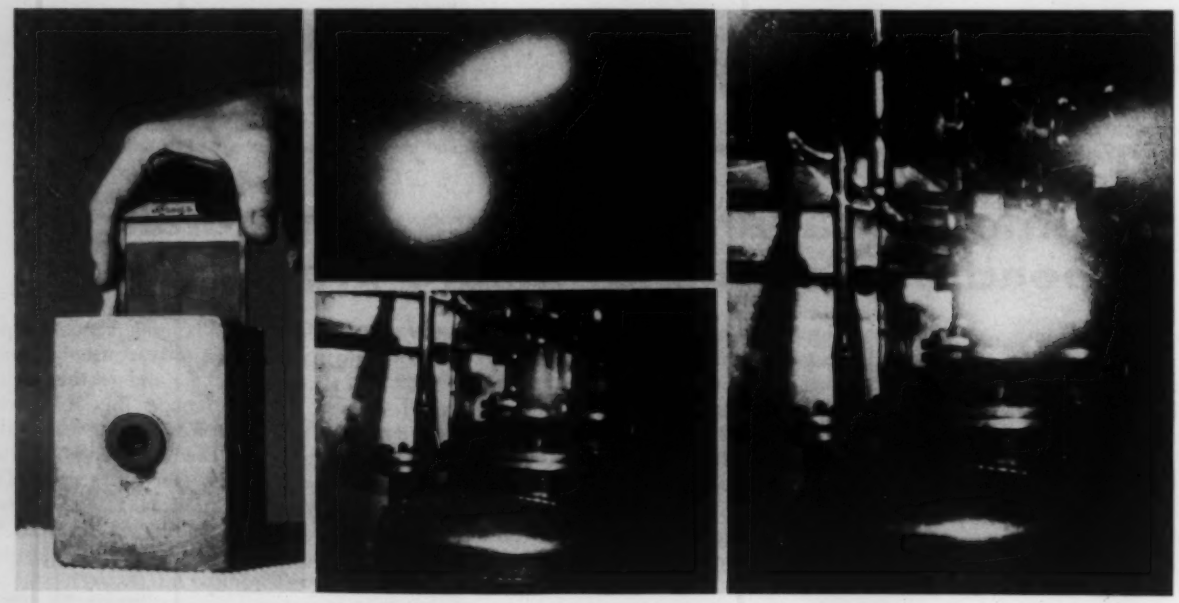
Sponsor of the conference is the ASME Machine Design Division. A highlight among the topics to be discussed, "The Information Center of Tomorrow," will depict future means for processing and interchanging engineering information. The schedule for the conference is as follows:

Monday, April 14

Panel session—*Putting the Design into Production*

Chairman and moderator—George F. Nordenholt, former editor, *Product Engineering;* vice chairman, Arthur Socolofsky, project engineer, Acme Steel Co.

Panel members—Leo Kevitt, manager, Manufacturing, Instrument, and Alemite Div., Stewart-Warner Corp.; Joseph Manuele, director, headquarters quality control, Westinghouse Electric Corp.; Donald L. Harwood, vice president, purchases, Fairbanks, Morse & Co.; H. Walter Regensburger, chief engineer, General Engineer-



LEAD PINHOLE CAMERA can be used to locate source of radioactive contamination. Designed at the Knolls Atomic Power Laboratory by a General Electric engineer, the 29-lb camera takes a conventional picture on one piece of film and records radiation on a sheet of x-ray film. By superimposing the x-ray film on the conventional film, scientists and technicians can accurately locate the radiation source in areas too "hot" for detection instruments. Photos show how camera located contamination on laboratory tank. Print at lower center was made from conventional film exposed to light rays entering the pinhole of the camera. At upper center, print made from x-ray film shows position of atomic rays. When one of these films was superimposed on the other and combination print was made, white blotches showed location of contamination.

. . . Fluid Power news

NEW BULLETIN No. 10600 "ANY-SPEED" DRIVES

WHAT OILGEAR FLUID POWER "ANY-SPEED" ROTARY DRIVES CAN DO FOR YOU!

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32 Pages

Reveals what Oilgear Fluid Power "Any-Speed" Drives are doing, can do, and could do for you on diversified rotary applications. Included are typical performance curves, graphs, applications, and comparisons with other rotary drive methods.

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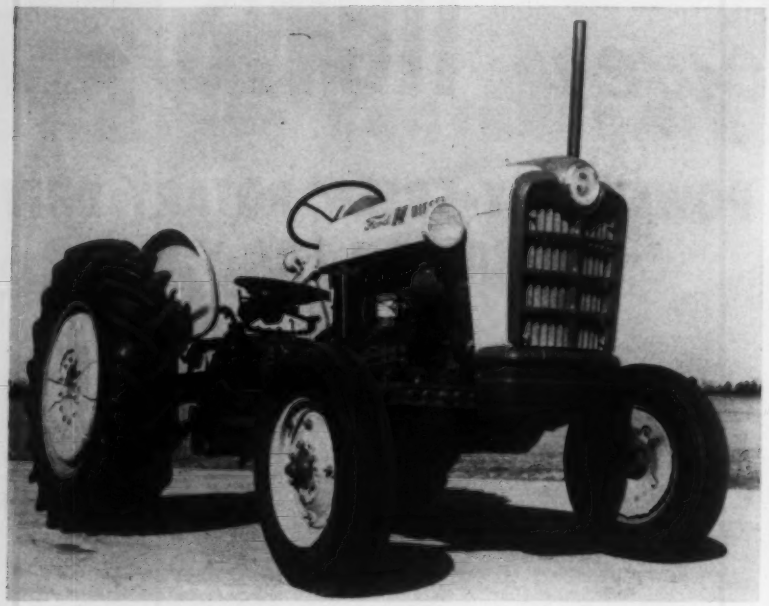


FORD'S FIRST DIESEL powers a line of farm tractors. Design of the new four-cylinder, OHV, direct-injection engine permits maximum parts interchangeability with the company's gasoline tractor engine; design of the tractor allows use of all farm equipment in the Ford line without modification. Engine specifications include displacement, 172 cu in.; bore and stroke, 3.90 x 3.60; compression ratio, 16 to 1; power (at drawbar, with four or five-speed transmission) 35 bhp at 2000 rpm. A 12-volt electrical system is used, with optional manifold heater plugs or ether cell starting aids for cold-weather operation

ing Dept., Link-Belt Co.

Tuesday, April 15 (Concurrent)

MECHANICAL SESSION

Chairman—Colin Carmichael, editor, MACHINE DESIGN; vice chairman, J. James Stone Jr., chief, Systems Engineering Div., Battelle Memorial Institute.

Mechanical Memory Devices. By Arthur Mirel, assistant section manager, General Engineering Laboratory, American Machine & Foundry Co., Greenwich, Conn.

Automatic Inspection Devices. By David H. McConnell, manager, Autometrology Div., Sheffield Corp., Dayton, Ohio.

MATERIALS SESSION

Chairman—Henry R. Clauser, editor, *Materials in Design Engineering;* vice chairman, James E. Johnston, vice president, Custom Molding Div., Chicago Molded Products Corp.

Effects of Rate on Tensile Properties of Plastics. By G. R. Rugger, chief, E. McAbee, and M. Chmura, Plastics Materials Testing and Specification Unit, Picatinny Arsenal, U. S. Army, Dover, N. J.

Uncommon Engineering Metals. By John P. Denny, physical metallurgy specialist and Louis F. Kendall Jr., nuclear materials specialist, General Engineering Laboratory, General Electric Co., Schenectady, N. Y.

POWER AND CONTROL SESSION

Chairman—Frank J. Oliver, editor, *Electrical Manufacturing;* vice chairman, Theodore A. Wetzel, chief engineer, research and development, Kearney & Trecker Corp.

Electrohydraulic Systems on Machine Tools. By Edward J. Rivoira, manager, Electrohydraulic and Gaging Div., and Albert A. Dall, director. standard machine tool engineering, Cincinnati Milling Machine Co., Cincinnati, Ohio.

Electrohydraulic Control Systems for Aircraft Applications. By F. L. Moncher, director of engineering, Aero Hydraulics Div., and L. D. Taylor, assistant chief development engineer, Research and Development Dept., Vickers Inc., Detroit.

Wednesday, April 16 (Concurrent)

MECHANICAL SESSION

Chairman—C. T. Blake, director of engineering, Warner & Swasey Co.; vice chairman, G. A. Nothmann, manager, Mechanical Engineering Dept., Armour Research Foundation.

Topics

Comes the dawn and with it Russian lessons via a Schenectady, N. Y., television channel. Twice a week, from 6:30 to 7 a.m., instruction in Russian is broadcast in an attempt to teach the language to the many technical people in the area. Aimed primarily at persons desiring to read Russian technical material, the course should help solve the problem of rendering such information useful to American engineers and scientists.

• • •

Los Angeleans have to get up early in the morning too, for a scientific TV course. "Space School" from 7:30 to 10 a.m. Saturdays offers discussions on such subjects as earth satellites, lunar flight, rocket propulsion, space medicine, and the exploration of Mars. Not for the plastic bubble-helmeted set, these programs are on a post-graduate level.

• • •

Outdoor-type brain recently proved useful in tabulating golf tournament results. A desk-size computer, product of Librascope Inc., was tucked in with the clubs and caddy carts when company employees set off for a golf outing. Tournament results were available minutes after the last golfers finished.

• • •

Sputnik in semantics is as sly as it was in getting into space. Last October we learned that the noun "sputnik" means satellite, or fellow traveler. As a verb the word means to entangle, mix up, confound, embarrass, perplex, trammel, and fetter. This information was submitted recently to the *Wall Street Journal* by William H. Buchanan, who allows that that Sputnik embarrassed and perplexed us for a while. "Let us hope," says he, "that it doesn't trammel and fetter us."

• • •

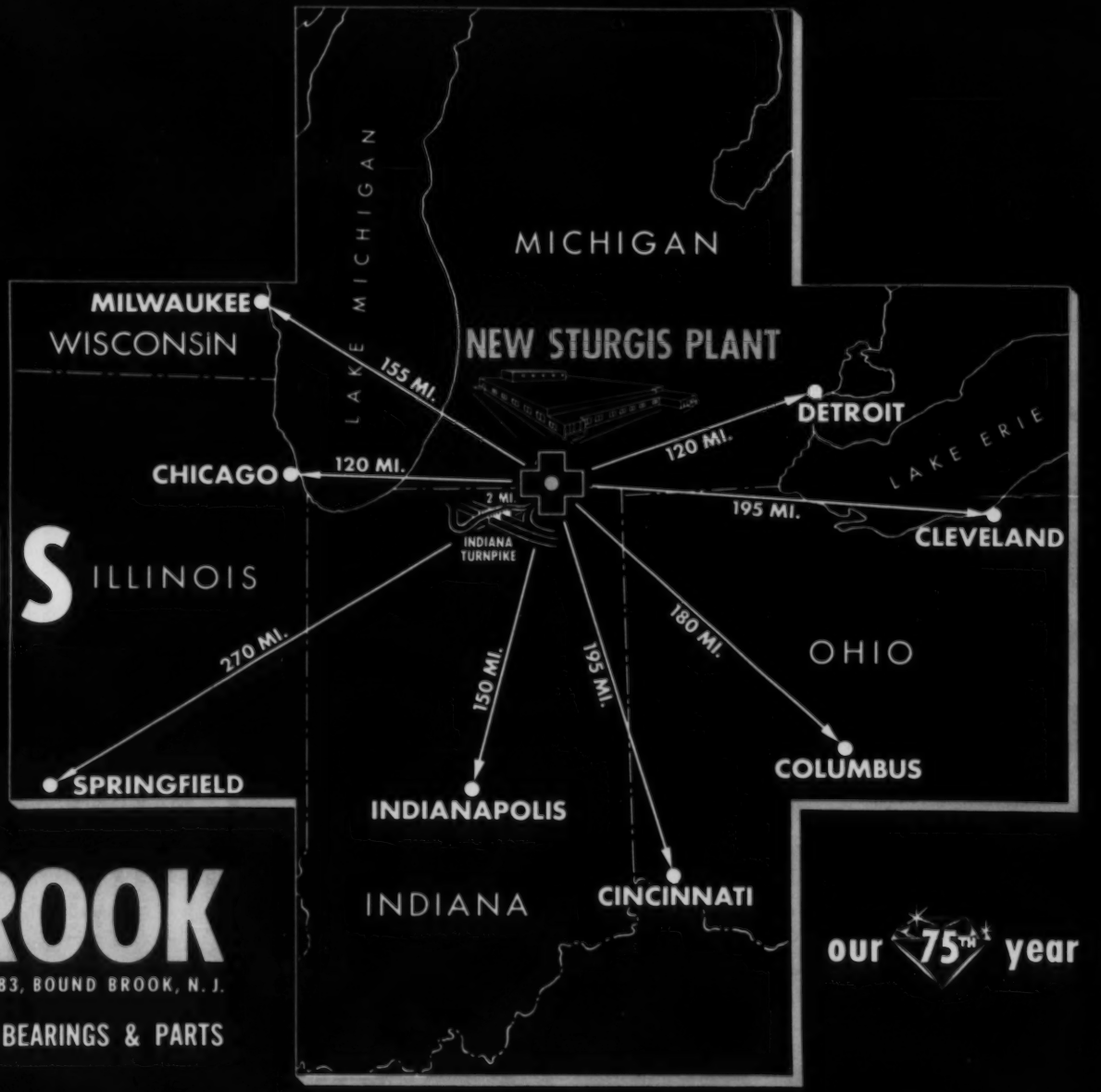
An inch is an inch is an inch—or is it? Of the English-speaking inch-users, the United States, Canada, and the United Kingdom each define the inch differently; Australia has no fixed standard. The differences, although less than a hundred thousandth of an inch, are too great to meet present requirements for accurate measurement—in production of missiles, for instance. Advocates of standardization point out that present differences might seriously limit the exchange of defense products.

Circle 407 on Page 19→

NEWS ITEM NO. 3 1958

SERVICE FROM STURGIS ANOTHER BIG PLUS

This second plant, now under construction, makes Bound Brook your neighbor. Deliveries possible within hours — any place — in the great industrial belt of the United States.



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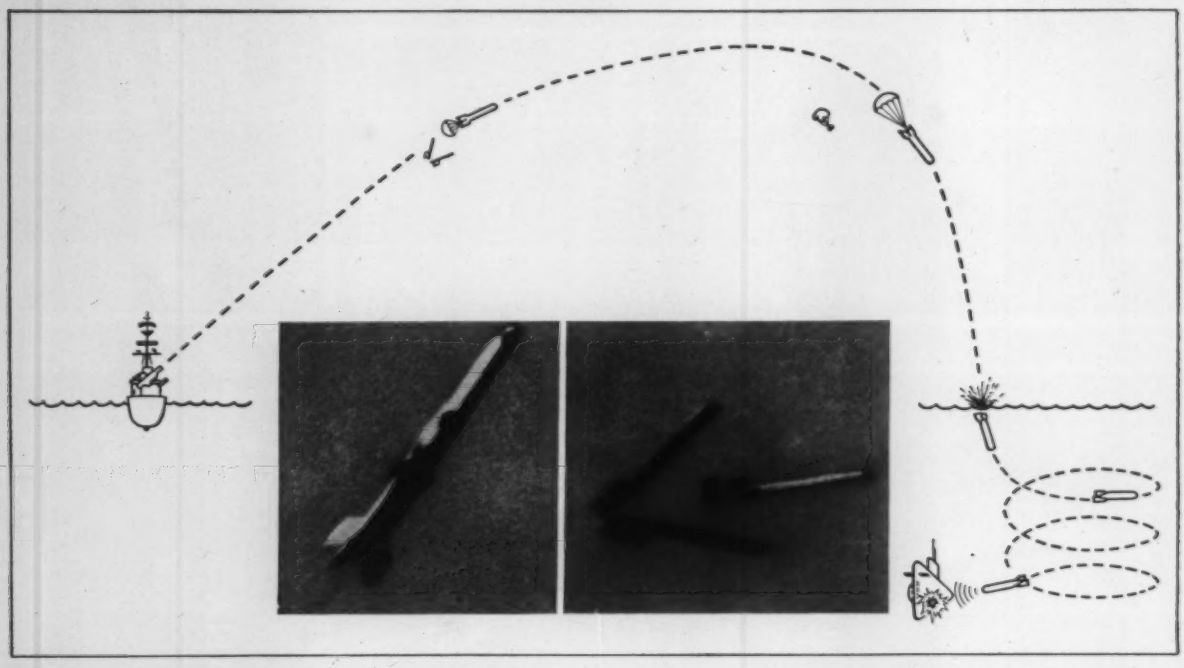


RAT, a new rocket-launched antisubmarine torpedo developed by Naval Ordnance Test Laboratory, will join the fleet this fall. The 16-ft missile has four parts: Booster rocket motor, stabilizer pack with parachutes, homing torpedo, and airframe package. As *Rat* approaches target after launching, airframe is discarded and parachutes open to stabilize flight and give the torpedo proper entry speed. Beneath water the torpedo sheds parachute and nose cap to seek out target. Launching mechanism, complete with automatic loading system can be built into existing 5-in. gun mounts on most U. S. destroyers. The new weapon will eliminate close-range, depth-charge combat; enable sub-chasing destroyers to stay out of torpedo range

Problems in Designing Automatic Machinery. By Maurice J. Faltot, assistant chief engineer, New Jersey Machine Corp., Hoboken, N. J.

Lubricant Considerations in Centralized Systems. By Robert K. Gould and Richard D. Skoglund, Texaco Research Center, Texas Co., Beacon, N. Y.

MATERIALS SESSION

Chairman—Walter Starkey, associate professor, Mechanical Engineering Dept., Ohio State University; vice chairman, Norman E. Bateson, deputy director of research, Pullman-Standard Car Manufacturing Co.

Compatibility of Metals in Bearing Contact. By Carl L. Goodzeit, senior research engineer, General Motors Research Staff, General Motors Co., Detroit.

High Strength Structural Sandwich Construction. By W. E. Dirkes, chief, Plastic Products Section, Wright Air Development Center, U. S. Air Force, Dayton, Ohio.

POWER AND CONTROL SESSION

Chairman—E. M. Ramburg, vice president, engineering, Titeflex Inc.; vice chairman, Sidney Davis, consulting engineer.

Integrating Mechanical and Electrical Design in Servo Systems. By Walter L. McCann, assistant chief engineer, Giddings & Lewis Machine Tool Co., Fond du Lac, Wis.

Solving Mechanical - Electrical Problems in Servo Systems. By Glenn Ertell, Specialty Control Dept., General Electric Co., Waynesboro, Va.

Thursday, April 17

GENERAL ENGINEERING SESSION

Chairman—William Budington, associate librarian, John Crerar Library; vice chairman, E. H. Cann, assistant manager, Graphic Reproduction Sales Div., Eastman Kodak Co.

The Information Center of Tomorrow. By Allen Kent, associate director, and James W. Perry, director, Center for Documentation and Communication Research, Western Reserve University, Cleveland.

A Central Catalogue File Saves Engineering Time and Money. By James L. Dykes, supervisor, commercial records management, Engineering Dept., E. I. du Pont de Nemours & Co., Wilmington, Del.

Rhodium-Plating Method Prolongs Motor Life

Prevents Radio Interference, Lowers Power Consumption, By Use of the Barest Touch

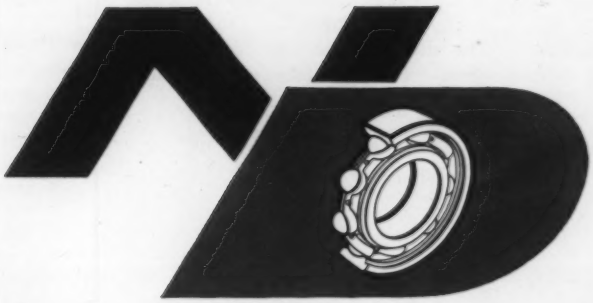
NEW YORK—A new method of rhodium-plating commutator segments is said to prolong the life of electric motors, while eliminating radio interference and reducing power consumption. Developed by Dalic Metachemical Ltd., the procedure also eliminates the danger of damaging windings, because commutators may be treated without having to immerse the entire armature in a corrosive plating solution.

The system is straightforward as in the usual Dalic process. Only one major piece of equipment is needed, a special rectifier with a finely graduated voltage regulator, which permits close control of the plating current. A lead from the rectifier cathode is clamped to a small lathe in which the arma-

NEW DEPARTURE

NEW DEPARTURE

NEW DEPARTURE



Symbol of a Reputation

. . . a reputation for integrity, for quality and service . . . for advanced creative engineering achieved by New Department in over half a century of precision ball bearing manufacture.

You'll find this emblem is also symbolic of our determination to continue, in the fullest measure, all those factors which have built that reputation. It is a visual pledge of this resolution to all our customers, present and future.

turning point of modern industry

1908–1958 GM FORWARD FROM FIFTY

NEW DEPARTURE

DIVISION OF GENERAL MOTORS—BRISTOL, CONN.

ture is rotated. The other lead has a special plating stylus, fitted with a pure graphite anode. The latter is wrapped in cotton and dipped into the proper plating solution. With 12 v dc applied, the wet anode is swabbed over the area to be plated, and a highly cohesive, nonporous coating is deposited.

Thickness of the deposit depends directly on plating time and current, indicated precisely by a finely graduated ampere-hour meter on the rectifier. Deposits of any reasonable thickness may be obtained with an accuracy of ± 5 per cent.

Future Feats Foretold Today, Says Research Head

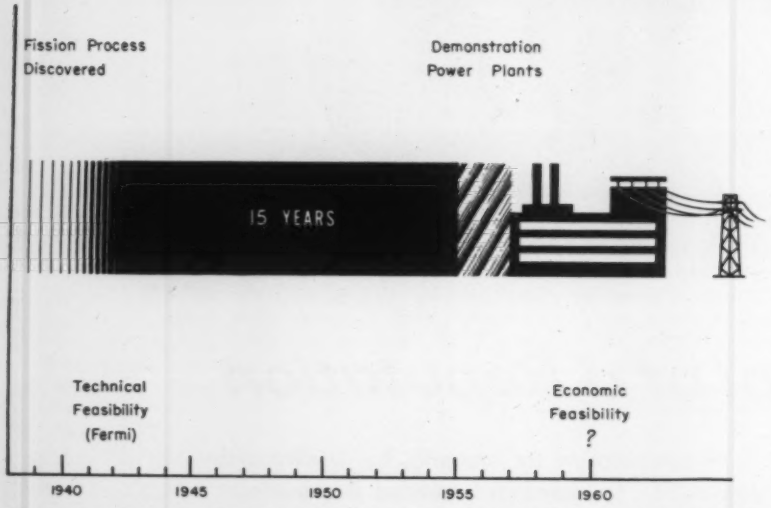
Gives Timetable For Development of Fusion As Compared with Fission

LOS ANGELES—Many scientific discoveries in the future may be seen before their actual arrival, a renowned research executive said recently. "As an example, it is a fact that a nuclear chain reaction was discussed in scientific meetings and technical journals five years before the discovery of the fission reaction. Perhaps this example and others that could be cited are evidence that the 'shadow of the future' may become clearer in the future," said Dr. Guy Suits, vice president and director of research of the General Electric Co. before an economics conference held at Stanford Research Institute.

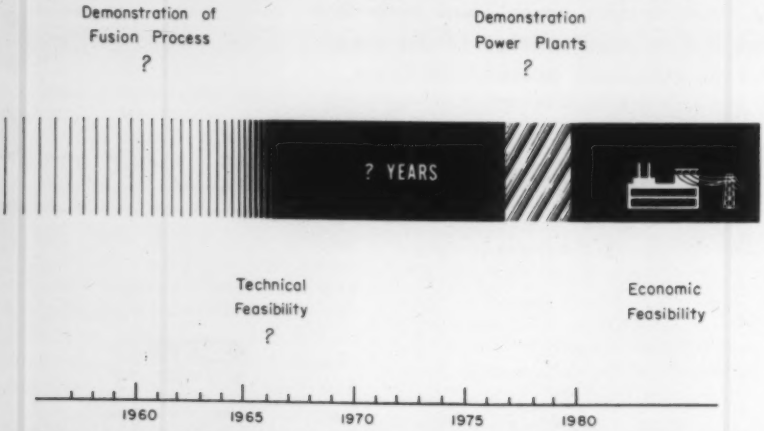
Dr Suits proposed a timetable for the development of fusion, based upon recent reported advances in achieving controlled thermonuclear reactions. He noted problems being faced in proposed fusion power plants which are strikingly similar to those met by fission power development:

1. Basic scientific phenomena require theoretical and experimental development.
2. Original solutions will be required at nearly every point in the development, engineering, and management work.
3. Large-scale power plants will be not large, but very large. Hence, pilot plants and demonstration power plants will be correspondingly large.

"Because of the ready availability of the history of fission and the similarities between the two cases," he said, "we believe that we can propose a chronology of the fusion development which has excellent validity." The time scales proposed by Dr. Suits show fission power optimistically identified as economically feasible in 1960, with fusion power identified as not economically feasible until about 1985.



Fission-power time scale identifies Fermi's demonstration of self-sustaining chain reaction as point of technical feasibility. Fifteen years of intensive scientific and technological development bridge the gap to demonstration power plants. According to Dr. Suits, of General Electric, 1960 may be taken as a somewhat optimistic date for economic feasibility of fission-power

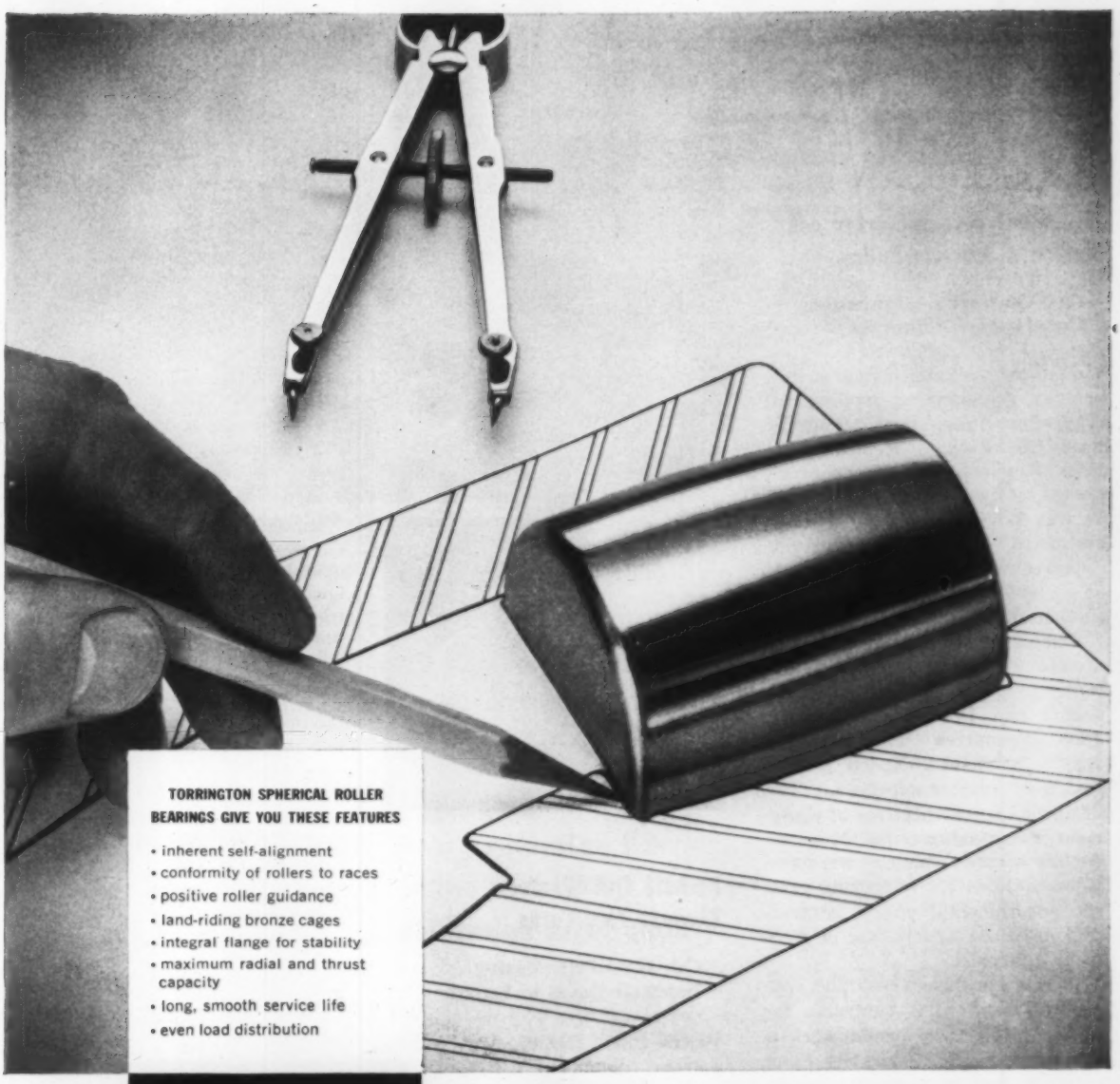


Fusion-power development is linked to fission-power time scale. Fusion time scale is based on question whether fusion is yet at the point where basic thermal process can be demonstrated. Another time barrier is the belief that fusion reactors will have to be very large. Question marks on scale show events may not be attainable. Dates suggest, if events are attainable, a reasonable time scale for their occurrence.

Superpowerful Atom Smasher Concept to be Reviewed

CHICAGO—A superpowerful nuclear accelerator has been designed by midwestern scientists and will be studied for validity. If the design is validated and supported by reviewing scientists, such a machine would provide the most powerful beam in the world. It would give nuclear scientists the experimental means of solving such fundamental problems as the force which holds the nucleus of the atom together.

Scientists of the Midwestern Universities Research Association have conceived, under grants from the Atomic Energy Commission, the National Science Foundation, and the Office of Naval Research,



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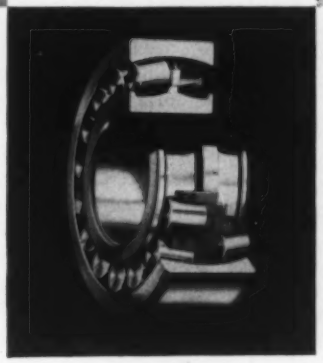

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an accelerator using a new principle, the colliding beam. Energy of the beam would be 500 billion electron volts equivalent.

Equipment Manufacturers Ask Clear U. S. Nuclear Policy

Cite Contracts, Information Practices for Improvement

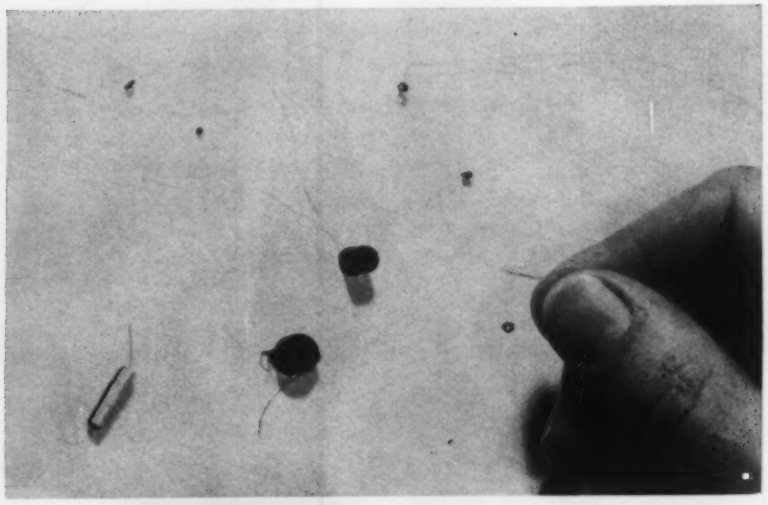
WASHINGTON—Participants at two one-day seminars on nuclear energy agreed unanimously that the most pressing requirement is a clear statement of the country's policy in the nuclear power field. It was pointed out that such a statement by the government is a prerequisite to the development of an effective U. S. program to further nuclear aims.

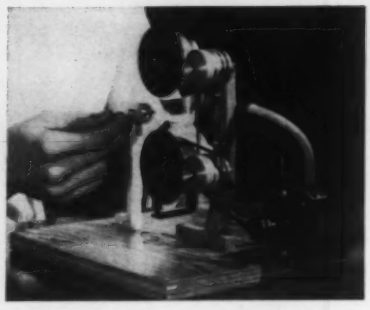
Summary of the seminars on atomic energy was released recently by the Subcommittee on Research and Development for the Joint Committee on Atomic Energy. Seminars included participation by reactor experts on Nov. 21 and by representatives of equipment manufacturers on Nov. 22. Among seminar findings were recommendations for improving present governmental policy, contracting practices, and release of technical information.

It was concluded that the concept of fixed price contracts for research and development work is unworkable and undesirable. Since research and development necessarily involves a high degree of uncertainty in initial cost estimates, it is not reasonable to expect the manufacturer to absorb the entire difference between original estimates and final costs, some of which may range up to 100 per cent or more. It was suggested that the cost-type of contract was generally more suitable.

As to the AEC's technical information program, participants at the seminars felt it to be generally adequate, although there was some feeling that considerably more material could be made available, and in specific areas, more time could be profitably devoted to informational activities.

Trained manpower was judged currently adequate.





"Pinhole" coils, above, were wound on prototype machine, left, developed by Stanford Research Institute. Quantity production of the tiny electronic components has previously been limited by lack of suitable winding machines.

Pinhole Coil Winder Threads Tiny Cores

Can Wind Coils Having Diameter Equal to Length

MENLO PARK, CALIF.—Tiny coils—a major component in miniaturized electronic circuitry—can be wound on a production basis with a new machine developed by Stanford Research Institute.

According to Stanford, most available machinery for winding small coils uses a split bobbin (or circular mandrel) to pull the extremely fine wire through the core hole. This has disadvantages: The hole through which a coil can be wound is limited to a dimension slightly larger than the combined size of the finished coil and the bobbin, and it is impossible in this manner to wind a coil through two adjacent holes in the same surface.

Stanford's machine is capable of winding coils whose outside diameter is equal to the diameter of the hole through which they are wound, either from the center to the outside of the core, or through two adjacent holes in the same core. Operation of the machine is not impaired by the diameter-to-length ratio of the core hole. For example, it is possible to wind a coil through two 0.010-in. holes spaced on 0.060-in. centers in a 3-in. thick core.

Set-up time on the laboratory model of the machine is about the same as on a standard commercial toroidal winding machine. Actual winding time per turn is about equal to a commercial machine.

Missile men, to aid in the design of tomorrow's weapons, are urgently needed. Redstone Arsenal and the Army Ballistic Missile Agency at Huntsville, Ala., are seeking qualified scientists and engineers for employment. The Civil Service Commission has announced an immediate and urgent need for chemists, engineers, electronic scientists, mathematicians, metallurgists, and physicists.

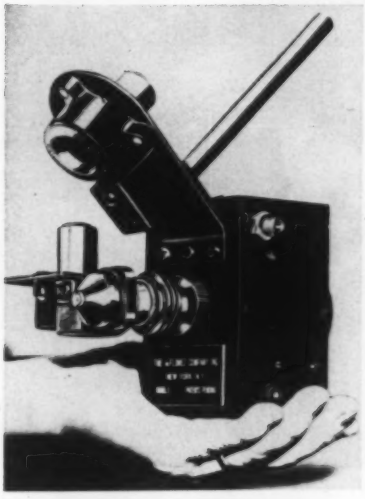
Information about the requirements to be met is given in civil service announcement No. 5-35-1(58) which may be obtained from many post offices throughout the country or from the U. S. Civil Service Commission, Washington 25, D. C.

Compact Optical System Pinpoints 100-w Light

Diminutive Source Ranges From 0.002 to 0.016 in. Diam

NEW YORK — A new point source of light has a compact optical system which concentrates the output of a 100-w mercury lamp into a small-diameter point of high intensity. Point sizes range from 0.002 to 0.016 in. diam. Intensities at these diameters are 3 to 300 candles, respectively. Beam width is a full 180 degrees.

Developed by the de Florez Co. under contract with the U. S. Naval Training Devices Center for a helicopter flight simulator, the wide beam from the point source will be used to project transparencies onto a curved screen in simulating flight conditions.

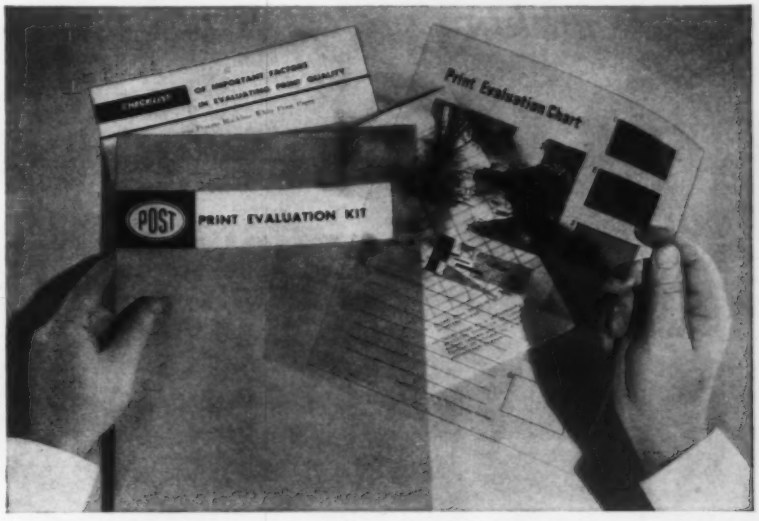


The 100-w, high-pressure mercury lamp is housed in a metal case. The optical system fits into an opening in the front of the case and comprises a condenser lens, objective lens, specially designed demagnifier and dispersal lens, and appropriate apertures and filters.

Prospective applications for the light source include forming shadowgraphs in TV, projecting intense light within exposed areas during surgical operation, and focusing high illumination on specimens in microphotography.

Power for the lamp is supplied by a remote power pack. The point-light source weighs approximately 4 lb.

DRAFTING TRENDS



This Gray Scale Film for rating print quality is included in POST'S new, free Print Evaluation Kit. Among other materials in the Kit is a handy Checklist highlighting important factors to look for in your prints.

New Evaluation Kit shows that many factors determine print quality

Progress in the technology of printmaking in recent years has been tremendous. Despite outstanding developments in reproduction equipment and in print papers and cloths, the yardstick to decide acceptability of a print still remains the same—its *readability*

Since print appearance is so vital in properly transmitting design ideas to plant, field and customers, it is increasingly important to be familiar with all factors that contribute to print readability.

A newly-developed Print Evaluation Kit is now available that goes a long way to help appraise print quality. As coater of a broad range of blueprint and diazotype papers, Frederick Post Company originally developed a number of the materials in this Kit for its own Laboratory use, in order to check its own papers against competitive products.

Materials for rating print quality

The Kit includes various materials useful in helping to rate print quality: an evaluation chart (gray scale film), a rating device and a checklist that reviews a variety of factors, such as image color, stability of line and background, keeping qualities, etc. Several "check points," useful to machine operators in analyzing troublesome print characteristics, are included.

Your Kit will be tailored to your needs

Send today for further information on this free Kit. Variations of this kit are available to suit your print making equipment whether it is an ammonia process or semi-moist machine, whether you favor bluelines, black on white or blueprints.

Write Reader Service Division of Frederick Post Company, 3652 N. Avondale Avenue, Chicago 18, Ill.

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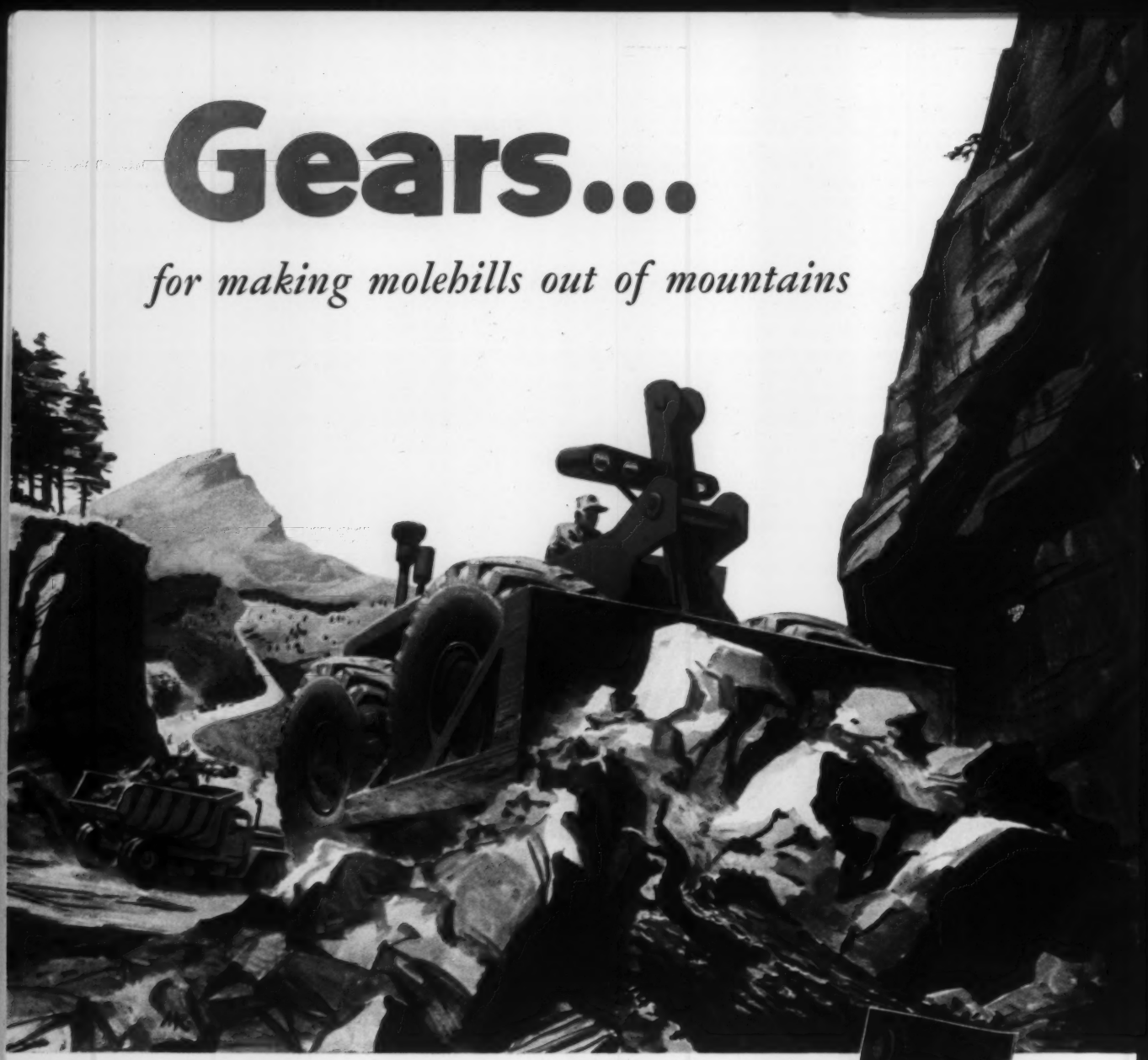
Gears...

for making molehills out of mountains



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Our salesmen are experienced gear engineers. Why not talk to one about your gear requirements?

May we send you a copy of this comprehensive catalog on the many gear types in which we specialize?

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415	440	465	490	515	540	565	590	615	640	665	690	715	740	765
416	441	466	491	516	541	566	591	616	641	666	691	716	741	766
417	442	467	492	517	542	567	592	617	642	667	692	717	742	767
418	443	468	493	518	543	568	593	618	643	668	693	718	743	768
419	444	469	494	519	544	569	594	619	644	669	694	719	744	769
420	445	470	495	520	545	570	595	620	645	670	695	720	745	770
421	446	471	496	521	546	571	596	621	646	671	696	721	746	771
422	447	472	497	522	547	572	597	622	647	672	697	722	747	772
423	448	473	498	523	548	573	598	623	648	673	698	723	748	773
424	449	474	499	524	549	574	599	624	649	674	699	724	749	774
425	450	475	500	525	550	575	600	625	650	675	700	725	750	775

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Mar. 6, 1958

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403	428	453	478	503	528	553	578	603	628	653	678	703	728	753
404	429	454	479	504	529	554	579	604	629	654	679	704	729	754
405	430	455	480	505	530	555	580	605	630	655	680	705	730	755
406	431	456	481	506	531	556	581	606	631	656	681	706	731	756
407	432	457	482	507	532	557	582	607	632	657	682	707	732	757
408	433	458	483	508	533	558	583	608	633	658	683	708	733	758
409	434	459	484	509	534	559	584	609	634	659	684	709	734	759
410	435	460	485	510	535	560	585	610	635	660	685	710	735	760
411	436	461	486	511	536	561	586	611	636	661	686	711	736	761
412	437	462	487	512	537	562	587	612	637	662	687	712	737	762
413	438	463	488	513	538	563	588	613	638	663	688	713	738	763
414	439	464	489	514	539	564	589	614	639	664	689	714	739	764
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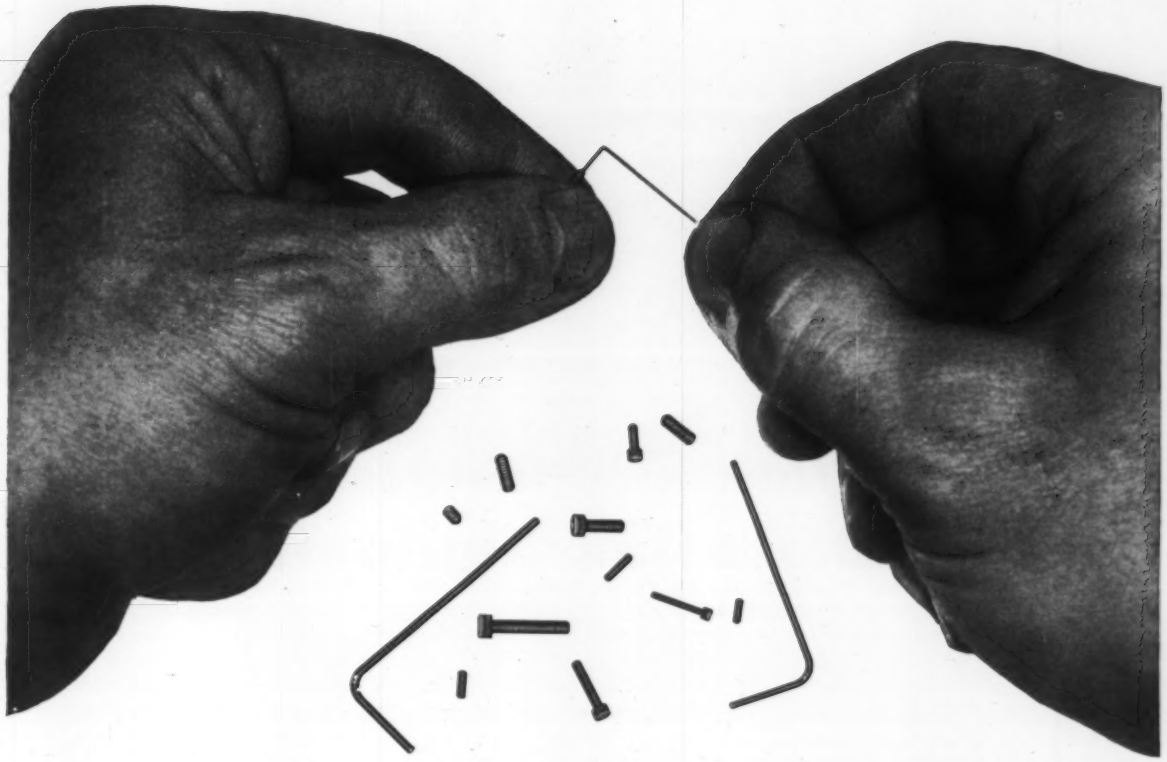

If you're miniaturizing . . . you'll save space, time and money with Allen Minicaps and Minisets (#0 thru #3 dia.)

These miniature Allen Hex Socket Cap and Set Screws will let you scale down your product sizes even farther. They're made from Allenoy special alloy steel — so strong that you can safely specify fewer screws or smaller sizes.

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Because sockets are uniformly true hexagon shape, the key or driver fits tight — makes starting much easier, saves a lot of time in assembly.

Diameters of these miniatures run from #0 through #3. Minicap lengths run from ⅛" through ½", and Miniset lengths from 1/16" through ¼". Also standard in stainless steel. Your Industrial Distributor has them now. He'll show you why these Allens — like all Allens — hold tighter and last longer. Or write for information and samples.

Use Minicaps and Minisets wherever you need dependable fastening in very small assemblies:

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ALLEN HEX-SOCKET SCREWS HEAD

Circle 412 on Page 19

Business, big and little, . . .

. . . acknowledges the importance of recording its communications. Machines to expedite the job must vary with the complexity of organizations served, and designers have met the requirements with versatile, varied lines of . . .

Peirce Portable Secretary

Office Dictation Equipment

CONSISTENT with design trends in other product fields, current models of office dictation machines show that their designers aim for more and better performance from simpler, smaller, and lighter assemblies. Portability, versatility, and operational simplicity are the most publicized properties of this equipment. Transistors and plastics are heavy contributors to most recent improvements. One manufacturer introduces an all-purpose machine equally useful in or out of the office. It's shaped like a book; weighs 11 lb.

Based on size, weight, and capacity, dictating machines can be classified as miniatures, portables, multiples and extensions, and networks and systems. The smallest miniature weighs not quite 2 lb; records and plays back ½ hr of talk. Miniatures are battery powered and use either magnetic tape or wire as the recording medium. Manufacturers of both miniatures and portables emphasize that shape is quite as important as weight and over-all dimensions. Flat shapes seem preferred. Miniatures fit coat pockets, and even the largest portables fit desk drawers.

Most new models can be classed as portables even though many are likely to be used only on desk tops. The greatest variety of designs occurs in this class, too. Sources of power are batteries or line current from car or office—some use any of these.

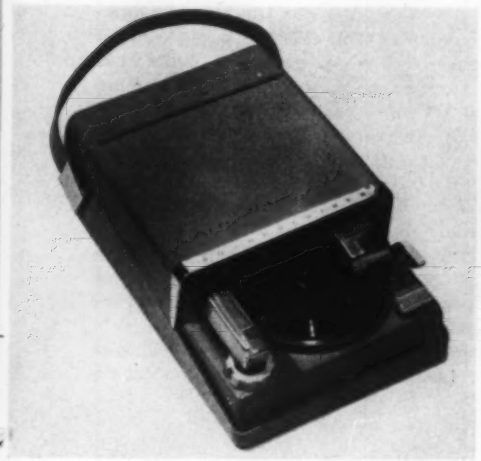
Recording mediums in portables are magnetic tapes or plastic sheets, with no decisive trend toward either one. Magnetic tape has either paper or plastic base and seems preferred over magnetic wire in portables and heavier models. Ease of handling is the advantage usually given for tape. In still larger magnetic machines, multiple recordings in the same length of medium make tape a necessity.

Plastic mediums for portables are in the forms of endless belts or discs, both thin in section. Thick wax or plastic cylinders are not used on any new machines. Belts have capacities as short as 30 min; as long as 24 hr. Discs of the smallest size record 8 min but are small and light enough to be mailed in the usual business envelope. Compactness, permanence, and low cost that permits disposability are stated advantages of the plastic medium forms.

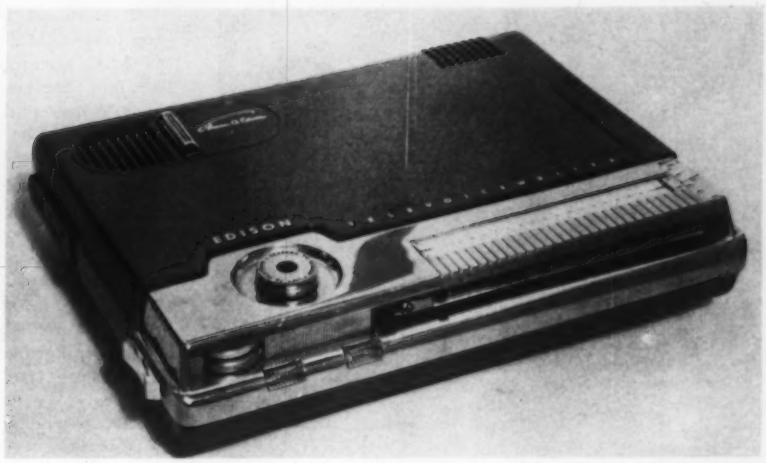
Conferences and all-day events soon exceed the limits of portable recorders. The manufacturers' answer is a group of multiples and extensions. Some work only when they're "spoken to," while long-playing models operate continuously—as much as a full day—to record events against a time scale. The most common multiple is an assembly of two like recorders fitted with means to transfer the recording from one to the other with a few seconds overlap. If an attendant changes belts while units are idle, conferences need never end.

Individual recording units do not grow in size to accommodate volume and variety of traffic. For fixed installations consisting of many offices, manufacturers provide centralized batteries of standard recorders tied to multiple dictation stations. Such a network can have its own lines and automatic switchboard, or it can use existing plant telephone systems, either PBX or PAX. If PBX, recorders are controlled by telephone dial codes.

Networks of this type—greatly varied—comprise the most expeditious business communications conceived to date. To improve them, designers might learn to document the office "grapevine."



SoundScriber Model 200-B



Edison TeleVoicewriter

Miniature Equipment

Dictet model MPA-2, by Dictaphone Corp., measures 2 x 4½ x 6$\frac{5}{16}$ in.; weighs 2 lb, 11 oz, less carrying case. It employs magnetic tape, each side of which accommodates ½ hr of dictation. Enclosed in a magazine, the tape itself need not be handled to load and unload the recorder.

Dictet is powered by two 6-v mercury batteries for the motor and one 6-v battery for the amplifier. Motor battery life is 20 hr approx. Simplified model MPA-1 does not have battery life meter nor start-stop controls on microphone, but on machine only.

Since larger, desk-top Dictaphone equipment records by embossing plastic belts, Dictet must have its own reproducing machine. The reproducer is intended for use on desk or stand, weighs 12 lb, 13 oz; measures 3½ x 11$\frac{5}{16}$ x 9⅝ in.

Minifon model P55s, by ABC Sound Engineering Co., employs magnetic wire. Spool supplied with the machine holds ½ hr of dictation. Larger spool holds 2 hr of talk. Minifon is powered by three batteries: one 1.5-v for the filament, one 30-v anode B-battery, one motor battery. The motor battery has the shortest life of the three—15 to 20 hr. Battery condition is signalled by a miniature meter. Minifon measures 1⅜ x 3⅞ x 6⅝ in.; weighs 1 lb, 12 oz.

Microphones include speaker type and throat mike. Two more are styled as a wrist watch and a tie pin. Range of the microphones is 20 ft.

Playback, under Minifon's own power, is through the speaker mike or stethoscopic earphones. Supplementary power enables playback through radio, TV, phonograph, or other recorders.

Portable Recorders

Stenocord machines, marketed by Pacific Instruments Corp., are portable or desk-top dictator-transcriber combinations dependent on external power sources. Model D measures 11¼ x 9 x 3¾ in.; weighs 9 lb. Model C is ½ lb heavier.

Both models use a plastic-base magnetic belt—erasable, reversible, mailable. An audible buzzer signals 15 sec before the end of the belt. Both models have the same built-in scanning and selector indicator.

For dictation, model D employs a plug-in hand microphone which carries start-stop controls. As a transcriber, model D is controlled by a foot switch. Built-in controls adjust volume and tone of play-back through plug-attached earpieces or microphone.

On model C, controls for recording and play-back are built into the basic machine. Hand or conference microphones are used for both recording and play-back. The same telephone equipment can be used with either.

Portable Secretary model, by Peirce Dictation Systems operates on two self-contained batteries as well as car, home, or office current. It measures 2 x 6½ x 8¾ in.; weighs 4 lb, 14 oz, complete with batteries and microphone. Dictation for 15 min is recorded on magnetic belt—removable, mailable, reusable. Features are input-output volume control and index slip. Dual-purpose microphone enables dictation as well as instant play-back and review. Belt used in this portable also fits new Peirce PBX Master Recorder having size, appearance, and capabilities of regular desk-top line.

SoundScriber model 200-B Portable, by SoundScriber Corp., is powered by four standard flashlight batteries—only source claimed universally adaptable and available. Model 200-B dimensions are 2⅞ x 6¼ x 10 in.; weighs 6 lb. It records by embossing plastic discs: Mail Chute size of 15-min duration or Memo size of 8-min duration. They can be played on a 33⅓ rpm home phonograph. Portable 200-B has SoundScriber exclusive feature of two tone arms, one for recording, the other for transcribing. Play-back is through hand microphone with start-stop button.

Comptometer Commander

TeleVoicewriter, made by Thomas A. Edison Industries, is supplied in Executive, Executive-Secretarial, and Secretarial models. All are versions of a basic, all-purpose machine which measures 10 x 12 x 3 in.; weighs 11 lb. It records by embossing red vinyl discs each side of which receives 15 min dictation. Disc can be filed or mailed, but not erased. Less than 25 w operate the Voicewriter. Dictation is possible even though machine is subjected to jolts, as in a car, or tilting, as in a ship or plane. Range of sound frequencies recorded is from 5000 to 150 cps. A push-pull amplifier suppresses certain harmonics, and automatic controls limit stylus deflection so that vibrant and weak voices are recorded with equal clarity. Positioning of motor and power transformer help reduce electrical distortion and dust-tight case reduces record surface noise. Modulating light signal tells dictator machine is on and monitors quality of the recording. Audible signal warns near end of disc. Executive-Secretary model has separate remote controls of backspace mechanism and tone for both dictator and secretary.

Time-Master is the designation for Dictaphone's desk-top models. Model group P, with essential power controls in hand microphones, and model group TA, with hand or foot controls, are intended for recording stations. Models designated TC are combination recorder-transcribers, and models designated TT are mainly for telephone recording. All these models occupy a volume of 4½ x 9½ x 12½ in.; weigh 12 lb. Models RP are intercom-like speakers for dictation stations physically remote from recording stations.

All desk-top Dictaphones, above, employ a plastic Dictabelt on which recordings are made by embossing. The recording is permanent, does not erase. Belts can be filed and mailed.

Recording microphones range from hand-held models to conference types. Listening devices can be the microphones or ear units.

Walkie-Recordall is made in six models by Miles Reproducer Co. All are portable, battery self-powered, record by embossing safety-film Sonabands. Three models measure 4 x 9 x 10 in.; weigh 8 to 9 lb, have 3-hr recording capacity. Three other models measure 4 x 9 x 15 in.; weigh 10½ to 11½ lb, have 8-hr recording capacity. In each group of three models, one has a sensitivity radius of 4 ft; the others, 60 ft.

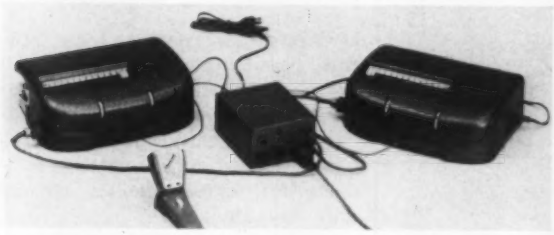
Optional accessories and attachments include a voice-activated control to start and stop recording automatically. Multiple microphones can be connected to the recorder and a telemike is available for two-way telephone recordings. Continuous recordings as long as 24 hr can be made and supplementary batteries will extend operation to 1000 work hr.

Commander model portable recorder, by Comptometer Corp., employs magnetic belt, weighs 15 lb, occupies space 10 x 6 x 9 in. New features in this latest Commander include a warning buzzer, restyled controls, improved microphone hanger. Buzzer sounds if user tries to dictate before lowering recording head. Same buzzer operates 10 sec before end of belt is reached. Output control knob, numbered 0 to 10, is memo of most suitable volume. Input control knob permits user to compensate for noisy environment or his own voice volume.

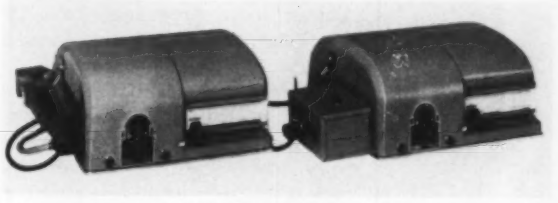
Tel Tape portable, magnetic tape recorder weighs less than 2 lb, measures 8½ x 6½ x 2½ in., operates on four commercial pen-lite batteries. It erases automatically, plays back through earphones, microphone, radio, TV. German-made, Tel Tape is marketed by Filnor Products.

Key-Noter model, by Gray Manufacturing Co., is portable addition to Audograph line of plastic disc embossing recorders. It measures 6¾ x 8¾ x 2¾ in.; weighs 5 lb, 10 oz; operates on 110-v ac current; records 20 minutes. Controls are Talk button, Listen button, scanning dial.

Multiple and Extension Recorders



Stenocord Model D—Continuous Hookup



Peirce Dual Recorder Control

SoundScriber Model S124

Lengthy conferences that exhaust the capacity of one recorder can be accommodated by a multiple-machine hook-up. Left is model D stenocord combination unit, shown, according to the scale indicators, at the instant of changeover. Also shown is similar arrangement of two Peirce model 560-EC machines, each recording on 15-minute magnetic belt.

Two-in-one arrangement is the Dictacord model by Dictaphone Corp.—essentially two desk model recorders connected in tandem and mounted atop a control unit. The assembly can be connected to monitor radio, telephone, or a PA system. The recorders use Dictaphone stock Dictabelts each of which yields a 30-minute record embossed in plastic. Automatic changeover from one to the other recorder includes an overlap (both belts recording) of 20 to 30 sec. Attendant can replace belts on idle recorders to enable unlimited recording. Unit measures 15¼ x 13¼ x 12½; weighs 45 lb, requires 125 w power.

Four-channel recording on one ¼-in. magnetic tape, up to 12 hr per channel, is the capacity of the Dictatape model made by Dictaphone Corp. Tape is started by remote control or voice relay in 50 milliseconds or less, moves past recording heads at 1⅞ in. per sec. Tape is paper base or film base. Floor mounted, the unit is 21¾ in. wide, 22 in. deep, 76 in. high; weighs 460 lb.

Full day—24 hr of continuous recording is obtained with SoundScriber model S-124 magnetic tape recorder-reproducer. Typical uses are: flight testing in the aircraft industry, load dispatching in the electrical power industry, documentation in radio broadcasting. Tapes that hold full day's events are 300 ft long, calibrated in minutes from 0000 to 1455, move past recording head at 2½ in. per min. Tape base is Du Pont Mylar film, selected for its high dimensional stability. For reuse, tape can be erased in 15 sec. The unit measures 6½ x 18⅛ x 11⅞ in.; weighs 26½ lb. Inputs are telephone, line, and microphone. Outputs are speaker and headset.

Recording Systems and Networks

Variable systems, distinguished by methods of control and means of transmission, are formed of Dictacord components by Dictaphone Corp.

Separate station system has special telephone-like handset at dictator's desk. Buttons on the handset permit dictator to control start-stop, playback, instructions, corrections and letter lengths on the recorder, and to communicate with the centralized recording station. System can have any number of handsets; up to six recorders. All recorders use Dictaphone Dictabelt—plastic, embossed, 15 or 30-minute capacity. Automatic features of the system insure against interference with recordings in process. Automatic switchboard is required for large installations. System is independent of conventional telephone systems, public or private.

Dictacord model RDS units function with telephone company's existing PBX system. Standard phones are connected with recording center through automatic PBX switchboard. Number codes dialed on handsets form connections and controls with the recorders.

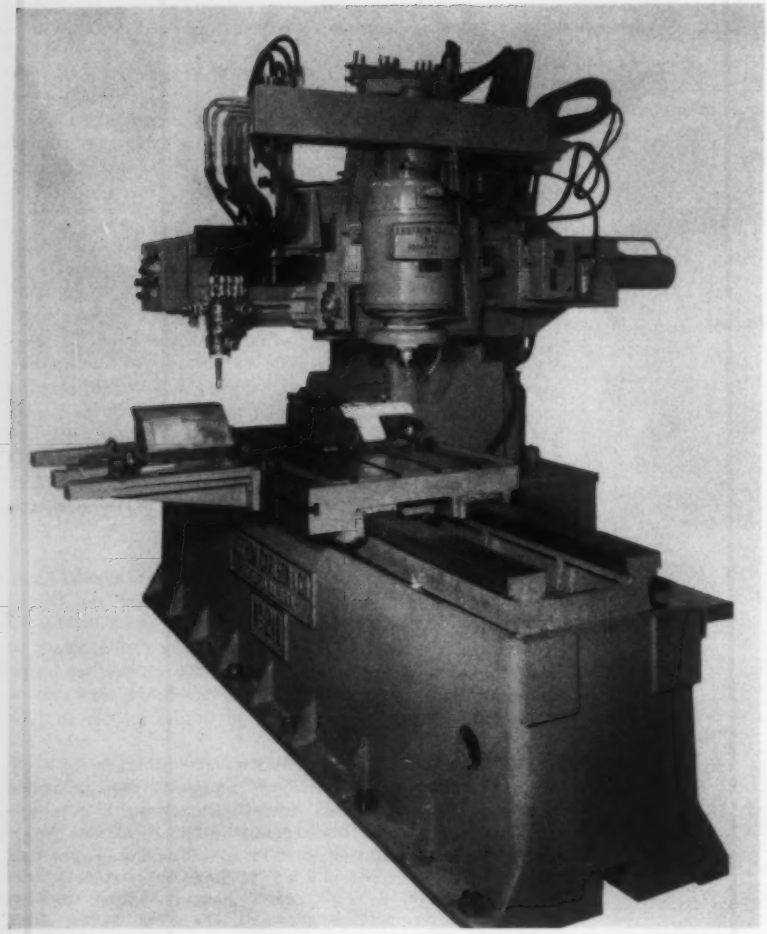
Model RDL units function with private, internal, PAX telephone system. Controls may be code-dialed, or handsets with dictation control buttons may be used.

Dictation networks by Peirce Wire Recorder Corp. are distinguished by the use of magnetic-belt machines. Multiples of recorders are connected depending on dictation traffic. Type of network depends on the number of dictation stations and the extent to which existing telephone facilities are to be used. At each remote dictating station, these controls are available: instant start and stop, positive automatic indexing, remote special instruction marking, flashback for review and error correction.

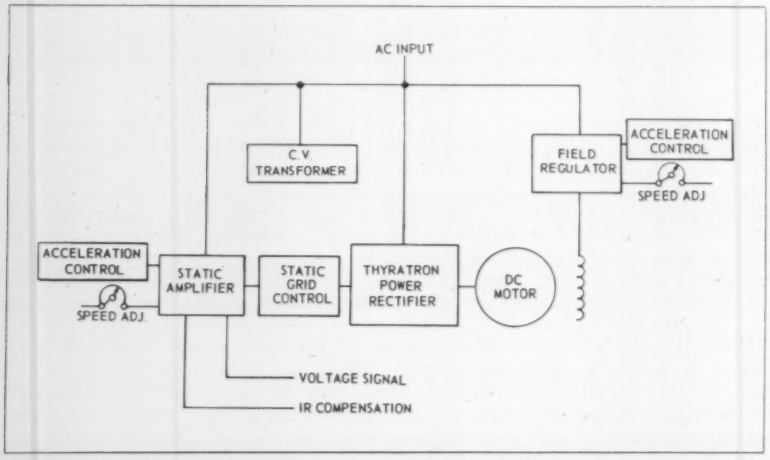
Model ADN, Automatic Dictation Network, connects up to 40 microphones with as many as 14 centralized recorders. System is independent of telephone lines. Lights on microphone cradles warn when all recorders are in use; also signal when recorders are free. Remote Microphone Network is the same except that it includes only one recorder.

Remote Telephone Network, in simplest form, consists of telephone-like handsets at several dictation stations and two central recorders. Handsets and recorders are added as system grows.

Peirce networks can also be tied to existing telephone systems, either PBX or PAX, in which case control of recorders is exercised by dialing three-digit codes.



FERROUS OR NONFERROUS metals can be milled on single machine. Wedding of three-dimensional profile mill with dc, water-cooled, infinitely variable motor permits machining various grades of aluminum, steel, and titanium at optimum speeds for maximum work production and cutter life. Milling machine, made by Ekstrom, Carlson & Co., is powered by Allis-Chalmers motor and control (below). Speed is variable: 50 to 6000 rpm



THREE-DIMENSIONAL milling machine speed is varied from 50 to 1500 rpm with thyratron armature control and 1500 to 6000 rpm by magnetic-amplifier field-weakening control. The control provides dynamic braking

Future Space Vehicles Promise Long-Range Weather Forecasts

WASHINGTON—There is a good future possibility of utilizing space vehicles to make weather predictions one or two seasons in advance, a government committee has concluded. Other possible missions for space vehicles include aids to navigation, communications, and trips to the moon and planets. This was brought out in a summary of recent briefings on nuclear space programs, held by the Joint Committee on Atomic Energy.

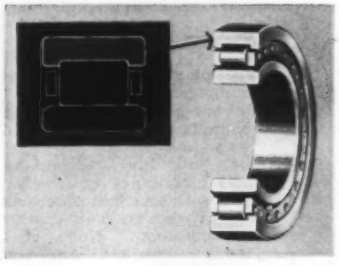
Government scientists at the meeting reviewed progress of nuclear power projects. Expert testimony covered Project Rover, the nuclear rocket program; Project Pluto, the nuclear ramjet program; auxiliary atomic power for satellites, and more advanced concepts.

One type of space power, ion propulsion—with a nuclear power plant to supply the energy for the ion propellant—has been suggested as a possible means for powering and controlling a vehicle once it is in space.

It was generally agreed that efforts to compete effectively with the Soviets in outer space propulsion will require a large scale developmental program and large outlays of funds, running into billions of dollars. The participants agreed further that in any future space program, close teamwork would be required between civilian development and Defense Dept. operations.

Involute Splines, Serrations, and Inspection is the subject of a proposed American Standard currently being circulated for criticism and comment. Sponsor is the American Society of Mechanical Engineers. The standard provides guidance and data for the design of straight involute spline teeth, dimensions for splines of recommended pitches, and a treatment of manufacturing errors and their effect on the fit between mating splined parts. Free copies are available from Frank Phillippbar, Standards Dept., ASME, 29 West 39th St., New York 18, N. Y. All requests should be made on company letterhead.

Loggers' "weight-lifter" tests bearing stamina!



TWO-LIP RACE INCREASES RIGIDITY

Two parallel shoulders made integral with the outer race, as shown in gray above, increase rigidity and durability—keep rollers in proper alignment. Precision-ground rollers and races give quieter, smoother operation.

Tossing around logs 6 feet in diameter like toothpicks is no job for a softie! This machine has to be *built* for it right from the start—*right down to the bearings.* And that goes, too, for the trucks which haul these back-breaking giants over the most rugged terrain. Bower tapered and straight roller bearings have been *engineered* for just such work as this—to last longer, perform better under any road or load condition. Painstaking quality control plus basic bearing design refinements—like those shown at left—have reduced Bower Bearing failure to a practical minimum. *Whatever* your product, if it uses bearings, specify Bower! There's a complete line of tapered, straight and journal roller bearings for every field of transportation and industry.

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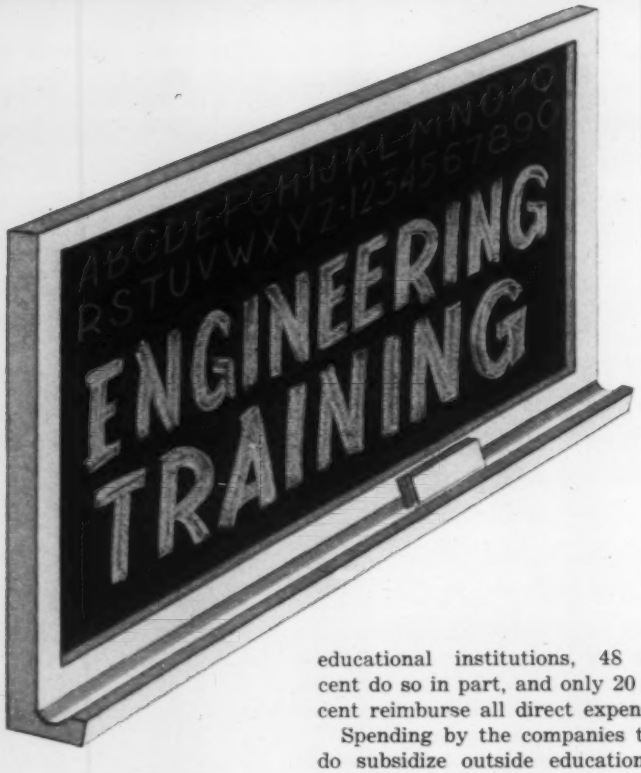
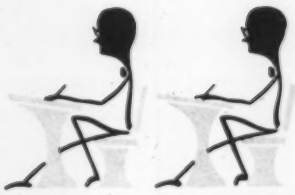
BOWER ROLLER BEARINGS

Circle 413 on Page 19





ENGINEERING TRAINING, both in-plant and extra-plant, contributes indirectly to engineering productivity. Indoctrination and training have been demonstrated to make the engineer not only more efficient but more effective as well. The replies to the survey, *Engineering Manpower:* How to Improve Its Productivity,* on which these articles are based, cited a variety of training program aims, indicative of the many approaches a company can take. Curricula must be made to fit the company's needs—to do a job which more fully equips engineers to contribute to their company's technical objectives.

Almost all companies that employ engineers sponsor training programs of one type or another. Of the companies contacted, 88 per cent stated they have in-plant training programs of which 31 per cent were formal and 57 per cent were informal or on-the-job type. It was found that industry does not consider extra-plant training and education as important to engineers as in-plant programs. This is reflected in part by the survey, which disclosed that 32 per cent of the companies do not subsidize education for their engineers at educational institutions, 48 per cent do so in part, and only 20 per cent reimburse all direct expenses.

Spending by the companies that do subsidize outside education is becoming big business. A recent survey of aircraft companies by the Aircraft Industries Association revealed that in a single year $480,000 was spent on 404 undergraduate, full-time students and $1,250,000 on 487 graduate students. No reliable figures are available for the totals spent by industry. However, it is obvious that such amounts are considerable and important to educational institutions.

In-plant training

In regard to in-plant training, one company reported, "It is our feeling that men learn best by doing . . . We . . . augment this with various training programs such as supervisory, human relations, process control, research seminars, and other business and technical training programs." A firm at the opposite extreme said, "We do not sponsor any intracompany program for training . . . It is our policy to provide employment . . . at good wages . . . Thereafter it is the responsibility of the employee to . . . spend them, waste them, or use them to further his education . . ." A middle-of-the-roader reported, "We believe that effective learning is best done in a position of responsibility. We therefore believe in . . . different . . . job assignments, coaching, and informal contact."

Two-thirds of the companies contacted feel their engineers are more effective if training is short and concerned with fundamentals. Though on-the-job training is potentially an excellent way to train new engineers, it was found that most companies do an inadequate job, owing to poor planning and lack of attention to rudiments. An engineering association noted these findings in its statement:

> • In-plant training programs for engineering and research personnel are generally inadequate. For example, in one machine-tool company engineering section of ten men, only four had had any practical experience or first-hand contact with the manufacturing processes by which their designs would be produced. None of the ten had an adequate appreciation of the costliness of different manufacturing processes.

In-plant training may be short or long. The short program is generally adopted to enable recently hired engineers to pick up product know-how quickly. The long program is almost always directed at recent engineering graduates who are new to the company. It provides trainees with a thorough knowledge of the company's engineering procedures.

*©1957, Engineering Manpower Reports

Industry Spends

Big Money on Blackboards

In one formal and extensive program, the course given to all graduate engineers is of three years duration. For the first year, the student attends class three days a week and takes prescribed courses. He works the remaining two days of each week in his "home department," so-called because it was his choice at the time of hiring. For the second and third years, he spends one day a week in class taking courses he selected, with the advice of his home department supervisor, and spends the remaining four days working in his home department.

Classes are run very much like college with the inclusion of periodic quizzes, homework, study periods, and grades. Instructors include visiting university professors and the company's own lab men.

Another type of long program is that of an electric motor manufacturing company. It is considerably more simple and specialized. This company trains the new engineer at the drawing board. Often he replaces a more experienced engineer. This particular program has been found, generally, to satisfy both engineers and the company as well.

Nontechnical considerations

Engineers particularly can obtain better leadership traits if they are trained in job methods, supervisory relations and techniques, and conference leadership. By these means, they grow to understand how to get the most from the people working for them, how to organize and institute the most efficient methods for getting work done. To better the supervisor's understanding of people, it is advisable that he be given some training in human relations. A clearer knowledge of the reasons underlying people's actions and reactions enables the supervisor to handle his subordinates with the touch that brings forth their best efforts.

Many firms have done this job well. An airframe company, for

Checkpoints for Engineering Management

- ☑ **1. Is your in-plant training program well organized . . . does it assure background in fundamentals?**
- ☑ **2. Can methods for selecting teachers, personnel, or curriculum, be improved?**
- ☑ **3. Does the company encourage engineers to attend colleges and universities . . . to participate in activities of professional societies?**
- ☑ **4. Are the company's needs and resources considered, as well as the applicant's record, when an engineer is selected for outside training?**
- ☑ **5. Does the training group's function overlap the supervisor's responsibility for daily, on-the-job training?**

example, has hired an industrial psychologist to establish a program of supervisory development. The purpose of the plan is five-fold:

1. Teach skills in equitable handling of engineers.
2. Set reasonable goals by use of personal judgment.
3. Create a more pleasant working atmosphere.
4. Demonstrate what is expected of an engineer.
5. Achieve greater engineering productivity.

Proper selection of trainees is essential to any good in-plant training program. The prospective trainee should be carefully evaluated to determine: First, does he need to be trained for the job? Second, what kind of training will most benefit him and the company?

Good men require special training to reach their own pace, level, and direction in a minimum of time. Trainers can develop their potential. However, when lesser candidates are admitted to training programs and are not weeded out during the training process, they become a major item of misutilization and expense.

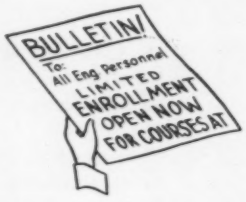
Extra-plant training

As training becomes broader and less concerned with job demands, industry agrees less on what kind of training is appropriate. A substantial number of companies and individual engineers resort to outside training. Extra-plant training may be considered to break down into three types; strictly technical, indirectly technical, and nontechnical.

Strictly technical programs relate directly to a man's work, and the company expects him to derive immediately usable benefits from them. To judge by the content of a number of programs reviewed in this survey, most applications for such courses are self-initiated, subject to the approval of company superiors. Applicability to the man's work is the strongest factor in obtaining approval. In some companies, the degree of applicability is the basis for tuition refunds. Here companies are looking for direct, short-range benefits.

Indirectly technical courses supply basic information, partly or wholly unrelated to a man's work. They offer future value. Companies select men for these courses more carefully because benefits cannot be immediately realized. One large rubber company encourages such courses and certain nontechnical courses "particularly for those engineers who show management possibilities to an outstanding degree."

Nontechnical programs are currently the least used. There is, however, a growing feeling that these are the most needed. There appear to be two basic reasons for this feeling. Both stem from the finding that most engineers did not receive a broad education in college. The first reason is that, in modern business, as the importance of engineering increases, good engineers soon become supervisors and managers. Their responsibilities broaden as they climb the managerial ladder and, therefore, their education should be supplemented to suit their new responsibilities. Second, several outstanding scientists and engineering



educators voiced the belief that an engineer is better as an engineer if he has had a broad education. This, however, cannot be proved in the short run.

Other survey replies indicate nontechnical education is particularly helpful to the creative engineer because it stimulates his imagination. The replies state, further, that today's advanced technology requires a better founding in integrated education in science and the humanities, rather than in specialized training alone.

The companies contacted described four approaches to providing outside-the-plant education for their engineers.

Enrollment in a college or university upon company approval on a co-operative or continuous basis is the most commonly adopted method. The continuous program may require full-time attendance, but more often involves evening or afternoon sessions. The co-operative system, which is growing in popularity, is a working agreement between the company and a particular school which combines work and study for the student.

Fellowship and assistantship funds are set up by some companies at schools in which their employees, or often anyone qualified, may work toward a degree. Funds granted for advanced degrees are generally stipulated to be used for specific kinds of technical study.

Institutes have been created and are run by many companies. One prominent example is that of the General Motors Institute. It is governed by GM executives, staffed by professional educators, and financed by the corporation. Most of its programs are at the undergraduate level. They heavily accent automotive engineering, although some liberal arts courses are offered too. Students are graduated with a bachelor's degree. The graduate's educational background, however, tends to be very restricted because of the narrow focus of the program.

Branches of established institutions are financed by some companies and set up near their plants. Such programs are generally of the graduate level for men who have the desire and, in the company's opinion, the ability, to continue their studies. The programs are administered by the parent school and all standards and entrance requirements are maintained by it. The major difference between the parent school and the branch is that students at the branch work for the company for part of each day.

Selecting candidates for outside-the-plant education is a difficult job for most companies. It can bring charges of discrimination and damage to morale. Almost all

companies rely on self-initiative to select applicants. Even so, there must be a limit, and some must be turned down. Where certain people must be selected, company needs usually come first. Added to this, generally, is an evaluation of the employee's record which involves a judgment of his ability to do the work plus a review of his previous educational record. The big limit is money. Companies who run fairly continuous programs must

set a budget. Experience is the main guide for doing this, matched again with total company needs and company resources.

Membership in professional societies

Also a part of the professional engineer's continuing education is his membership in professional societies. One survey showed that of 73 companies, 56 paid all dues to selected professional societies, 4 paid various percentages, and 13 paid nothing. To judge from current information, the number of companies paying dues is on the increase.

Next article in this series will appear in the March 20 issue. It will deal with the placement of engineers and discuss placement combined with job evaluation, basic reasons for assigning engineers to jobs, periodic appraisals, and psychological tests.

Recommendations for Management

1. Determine training objectives.

Before deciding on any curriculum determine what needs the training program must meet. Such forethought is essential, for much time, money, and talent can be expended on a program which, though excellent, fails to serve realistic company objectives.

2. Monitor on-the-job trainees.

Although on-the-job training programs are often the most useful, too many companies carry out such training poorly. Often, it requires only following up on the newly acquired skills of the trainee-graduate; bridging the gap between what he thinks engineering is and actual job demands.

3. Educate engineering supervisors

Management is strongly urged to make sure that engineering supervisors are thoroughly educated in "human relations" areas. It is necessary for supervisors not only to become expert in techniques, but to develop a sincere and spontaneous appreciation as well.

4. Screen trainees carefully.

Training efforts are useful to a company only if expended on properly selected trainees. In many companies, it is apparent that some trainees are literally in the wrong class. They either lack the ability or interest to absorb and benefit from the particular level of training, or have previously mastered what is taught in the program.

5. Consider outside training.

Although most companies do not sponsor such programs, it is well that management insist engineering administrators evaluate the pros and cons of outside-the-plant training. Technology's constant growth and increasing complexity strengthen the need for advanced technical training and appreciation of the humanities.

Says Future Trends Doom Planned Obsolescence

Designer Sketches World of Tomorrow

CHICAGO—Future innovations doom the manufacturer who lives on "stylistic obsolescence," a leading industrial designer told an audience of executives of the plastics industry recently. "We're going to see products become functionally obsolete so fast that it will seem absurd to think up ways of making them stylistically obsolete," said Henry Dreyfuss.

Fundamental changes in the design of homes, appliances, cars, and people were predicted by the noted product designer.

Talking about homes, he said, "At present, the spaces we live and work in tend to be rectangular . . . but nature isn't . . . The landscape outside our cities is made of softer forms, which I believe people instinctively prefer. I think we can expect to see more of these forms in our living spaces . . . Today we're beginning to have building materials . . . to create these soft forms, these flowing, interlocking spaces."

After questioning the future of objects inside the newer living spaces, he said that the premium on space must lead toward miniaturization, which can already be observed as the transistor permits the once-bulky radio to travel in our pockets. The deep freeze, he pointed out, holds a small packet that was once an enormous bag of unshelled peas. Side by side with miniaturization, he emphasized the built-in concept. Now in the luxury class, he conceded, the built-in concept is fundamentally economical and is marked for widespread adoption.

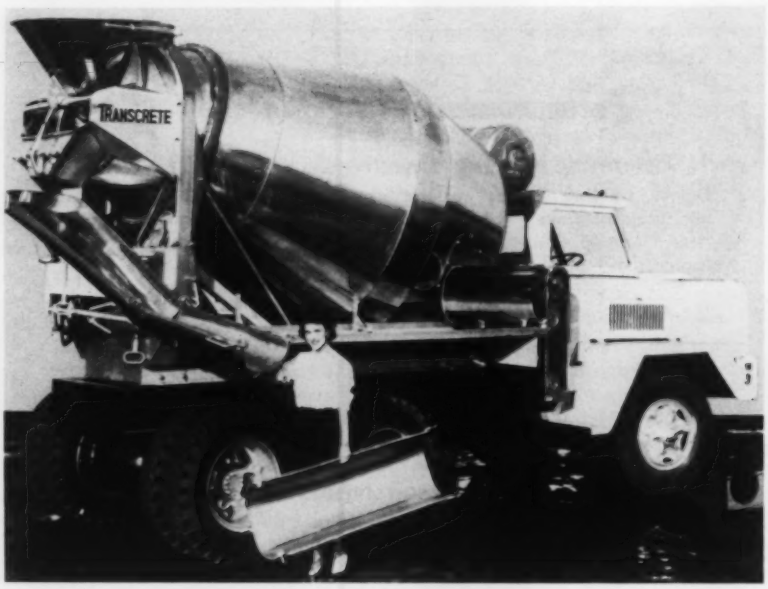
On the matter of cars, he deplored the exasperation of modern downtown parking. To cure this, he would cut down the overlap of private and public transportation. Instead, he would have them complement each other. He cited an example, "We might drive our cars to a super highway constructed as a network of monorails. We'd enter a monorail station, use rooftop hooks to hitch our cars into the monorail system, and whiz away at 150 mph along a route

LA GALAXIE, the latest advanced styling model at Ford, envisions the use of such operating features as an electronic proximity warning device. Longer, lower, and wider than the Thunderbird, the dream car would have butterfly roof sections to ease passenger entry and exit. Overall length is 223.6 in.; height, 51.8 in.; width, 80.1 in. Wheelbase is 126 in.—13 in. longer than the four-passenger Thunderbird.

punched on an IBM ticket. Arriving at the station nearest our destination, we'd be automatically eased off the monorail and drive on to wherever we're going under our own steam."

But we'll spend more time at home, he predicted. Working hours will be shorter, and improved products won't need painting—lawns won't need cutting. Industry, he said, will become a vast producer of home workshop equipment and do-it-yourself kits and will itself have to educate the consumer for leisure. Home entertainment will make our present TV screens seem little and crude.

He pictured people of the future, "Hopefully, a good deal of our new leisure will be spent on athletic fields, tennis courts, ski slopes, golf courses, and in swimming pools. Through athletics, we have the opportunity to become the healthiest and handsomest race in history."



CONCRETE EXAMPLE of weight reduction through use of aluminum is shown by this 7-yd mixer developed at Kaiser Aluminum. Entire ready-mix unit, with exception of drive train, is aluminum alloy. No basic design change was necessary. Dimensions of certain components were modified to employ high-strength, weldable aluminum alloys to best advantage. The various sections are expected to have the same strength as those fabricated from steel. Weight savings will result in increased delivery capacity; reduced return trip costs. Aluminum chute sections, less than half the weight of steel chutes, will save operator time and effort.

Exorbitant Costs Will Limit Navy Weapons

WASHINGTON—Future trends in Navy weapons will be limited by exorbitant costs and yet there is room for optimism, said the retiring chief of the Navy Bureau of Ordnance in a recent address. Speaking before the Washington Post of the American Ordnance Association, Rear Admiral F. S. Withington said, "There seems to be an equation which goes like this—higher performance equals greater complexity plus greater cost plus more acute maintenance problems."

Insisting that this equation must not be accepted as axiomatic, he suggested that it be attacked by

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  A standard feature which permits reverse free flow (up to 1400 cu. in. per min.) from outlet to inlet port by-passing control elements.
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  Retension of original feed rate is assured because a set screw prevents inadvertent throttle movement and a cover over the set screw can be locked in place.
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  No need to stock several valves for wide range of flow rates. Drain connection is eliminated, piping costs are reduced.
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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

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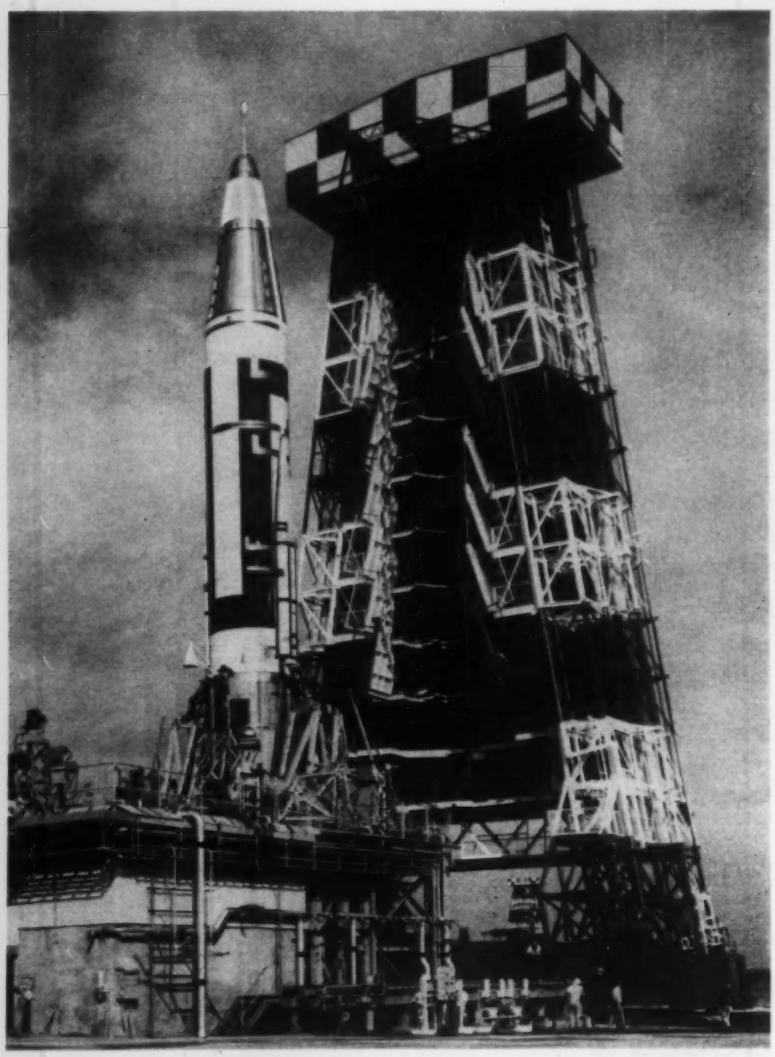
sound thinking in the initial engineering concept, realistic specifications, cost-conscious engineering, the use of standard stock items, and the reduction in number of actual hardware developments and missile growth problems.

He pointed out currently successful projects of the Bureau: The Sidewinder, Terrier, the nuclear depth bomb Betty, the Talos defense unit, high performance torpedoes, and improved mines, but said their success must be credited to his predecessors because the development time for weapons and weapons systems is so long.

His own efforts, he contended, would not be realized until some time in the future, also because of required lead time. But he predicted the following among coming trends in Navy weapons:

- Radical improvements will be made in torpedoes to meet the challenge of high-performance enemy submarines.
- Mine mechanisms will be more sensitive and more resistant to countermeasures.
- There will be fewer varieties of guided missiles and performance will be greatly improved.
- Means for detecting submarines will be much improved over present sonar.
- Improved radar will become available for both air search and missile guidance.



STANDING START FOR ATLAS is provided by this launching pad, gantry tower, and maze of wiring and plumbing. Tower moves on rails to straddle the pad during launch preparations. Work platforms installed at regular intervals in tower's center fold upward to permit movement. Tubular launching arms, at base of missile, hold and stabilize Atlas during final fueling and engine ignition; provide exact takeoff positioning.

Atlas blasts off with initial power furnished by two 135,000-lb thrust booster motors. Plume of flame at right is exhaust from fuel system turbopumps. Expendable launcher tubing on pad is consumed in fire.

To improve the utilization of scientists and engineers and to work toward resolving the long-range problem of technological education, the National Association of Manufacturers has established a Committee on the Utilization and Development of Scientists and Engineers. Primary purpose of the committee is the development of a program to meet the immediate needs of the country through efficient utilization of scientists and engineers who are already trained.

7 deadly reasons why so many business careers slow down so soon!

Why is it that the careers of so many men in business start off with a bang and end up with a whimper? What explains the gap between promise and performance?

There are, of course, many reasons—but seven stand out as the most common, the most deadly:

1 THE ILLUSION OF SUCCESS
Men are often lulled into complacency by routine promotions and small salary increases.

2 INCOMPLETE KNOWLEDGE OF BUSINESS METHODS
A successful executive must be familiar with every dept. of business – Marketing, Accounting, Production and Finance.

3 LACK OF SELF-CONFIDENCE
No man ever reaches the top unless he feels that he belongs there.

4 FEAR OF MAKING DECISIONS
It's impossible for anybody to attain success on a large scale until he learns the art of decision making.

5 INABILITY TO HANDLE MEN
Men who aren't able to lead others obviously can't go very far in business.

6 ABSORPTION WITH DETAILS
A man unable to delegate routine work allows himself to become bogged down by details.

7 LACK OF DEFINITE GOAL AND PROGRAM
Unless a man sets a definite goal for himself, he'll waste the most productive years of his business life.

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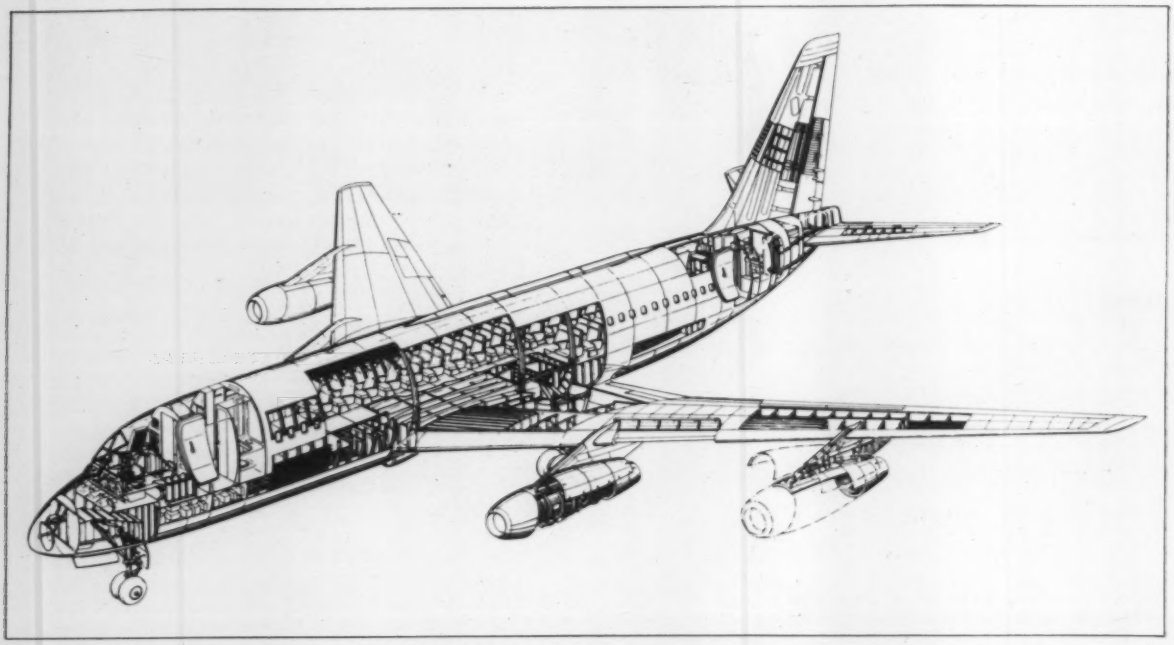
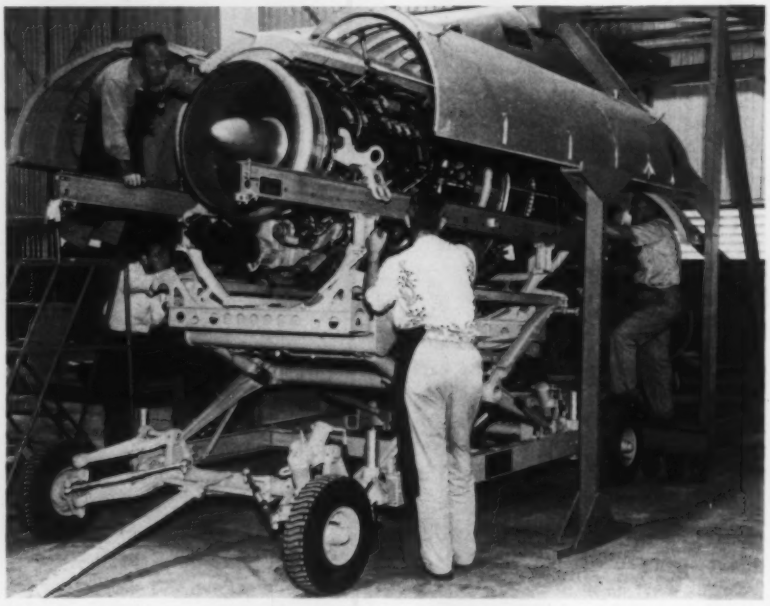


CONVAIR'S 880 JET TRANSPORT, scheduled for airline operations in early 1960, will be the world's fastest airliner, according to Convair officials. Four GE turbojet engines give the big 88-passenger plane a cruising speed of 615 mph. Flexible interior arrangement utilizes varying ceiling levels to compartmentalize the passenger cabin without use of partitions. Over-all design also includes provision for fast, efficient maintenance service. Engine change, below, requires 30 min. Removal procedure involves unfastening (with thumb and fingers) 18 latches to open the pod's clamshell, removing one bolt and two trunnions, disconnecting four clamps and five tubes, and pulling six electrical plugs. Engine and cart are then pulled away and a second engine and cart positioned.



Thinking Machines Need Thinking, Engineers Told

Digital Computer Value Rests with Organization

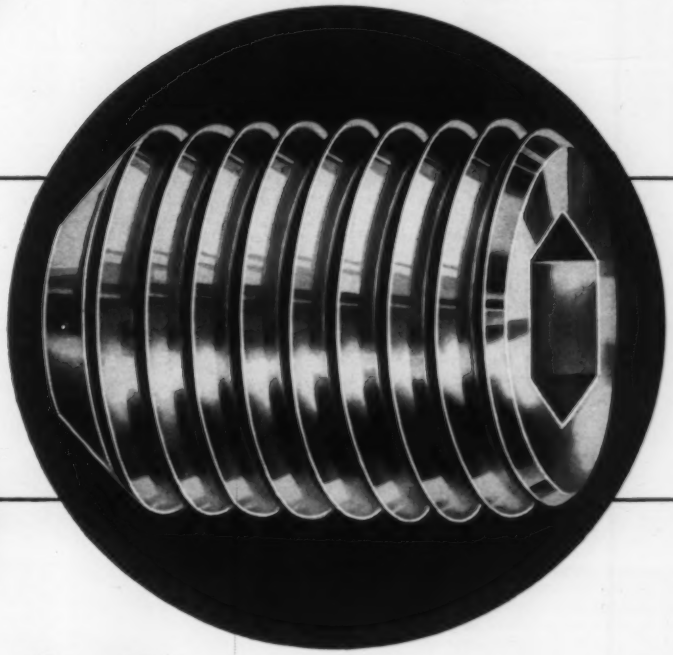
NEW YORK—The many problems involved in the use of "thinking machines" or digital computers are not being successfully thought through, according to a paper presented recently before the AIEE. Co-authors P. A. Abetti and S. B. Williams of the General Electric Co. said that because the art of applying digital computers to engineering is still in its infancy, it has been difficult to "think through" many computer applications.

In relation to the use of computers, the paper said, personnel should be divided into three groups:

1. The engineers, charged with responsibility for obtaining solutions to various problems.
2. The programming group, charged with the responsibility of preparing correct and economic programs for the selected applications.
3. The computer operations group, charged with the responsibility of running the requested individual jobs on the computer correctly, efficiently, and on schedule.

Those applications which have a high degree of repetitiousness should be selected for computers. The requirement of repetitiousness is dictated by the fact that at present, programming is laborious, expensive, and time consuming, and

Problem: *"Secure pulley to shaft with set screw. Head of screw should be flush with pulley collar to prevent injury to personnel. Set screw must hold firmly under vibration. Space for tightening and loosening is limited . . ."*



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(Advertisement)

STRENGTH WOUND INTO IT

Research has proved that a light flexible wire with several alternate layers of wire wound around it produces a cable more flexible than a single wire of the same diameter and is capable of carrying a much higher torque. Flexible shafts are composed of this type cable plus a flexible casing which provides protection from dirt, grime, or grease.

There are two types of flexible cables used in flexible shaft assemblies. One is the power drive flexible cable in which the wires are wound in alternate direction. The outer layer of wire determines the direction rotation and is made to tighten when in use to add strength and form a practically unbreakable unit. The main advantage of the power drive flexible cable is its simplicity of alignment, as it is capable of transmitting power over, under, and around any obstacle between the drive and the driven elements.

Power drive cable with wires partly unwound to show construction of the cable.

Section of remote control cable showing superimposed layers of wire wound in opposite direction.

The other type of flexible cable is the remote control flexible cable which due to being constructed of smaller gauged wires than the power drive cable, and wound by a special process, provides for both rotation and reciprocation such as the opening and closing of a valve.

Both of these flexible shafts may function in a continuous or intermittent operation with a minimum amount of vibration. They not only offer long lasting strength but also economies in cost, time and space.

Send for further details on how flexible shafting may be easily and economically incorporated into your design.

Write F. W. Stewart Corporation, 4311-13 Ravenswood Avenue, Chicago 13, Illinois.

Circle 417 on Page 19

KITCHENMACHINE, made in Germany by Robert Bosch Co., is a new entry in the U. S. appliance market. As its name indicates, the machine does a wide range of kitchen chores—almost single-handedly mechanizing the entire food-handling operations. With its 17 attachments and ½ hp ac-dc motor, Kitchenmachine mixes, blends, slices, peels, and grinds. In addition, it quickly adapts for ice cream making, grating, straining, paring, extracting, and reaming. It's a coffee mill, ice chopper, bean chipper, and noodle maker, and will mince 150 lb of raw meat per hr. It was designed for housewife and hotel chef alike.

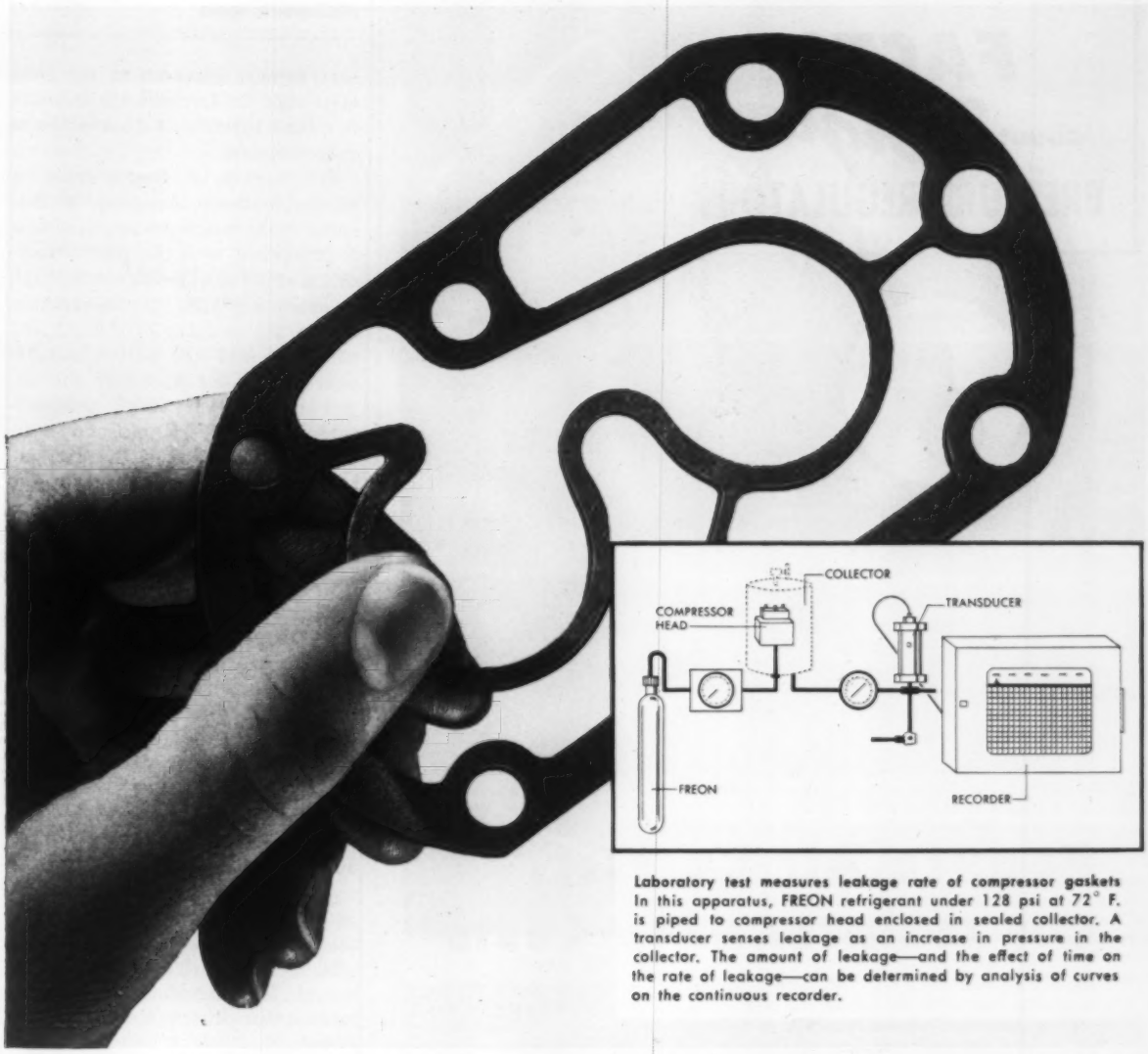
becomes the bottleneck in most installations. Programs always represent a high investment in dollars and hard-to-get manpower, and only high repetitive use of these programs insures an adequate rate of return of this investment.

The selection of the type and size of computer depends upon the application considered, the amount of usage, and organizational considerations. Larger and more expensive computers are required as the volume and the amount of engineering data processing increases.

New Science May Permit Acceleration of Rockets

Graduate School Head Tells Of Magneto-Hydrodynamics

WASHINGTON—How the new science of magneto - hydrodynamics may be used for the acceleration of rockets and for the safe return of artificial satellites to the earth's surface was described recently by the director of the Graduate School of Engineering at Cornell University. He said also



Laboratory test measures leakage rate of compressor gaskets In this apparatus, FREON refrigerant under 128 psi at 72° F. is piped to compressor head enclosed in sealed collector. A transducer senses leakage as an increase in pressure in the collector. The amount of leakage—and the effect of time on the rate of leakage—can be determined by analysis of curves on the continuous recorder.

Seal FREON* refrigerants at lower cost with new asbestos Accopac AN-890

Compressor manufacturers can now get more efficient sealing of FREON refrigerants with Accopac AN-890, a new asbestos gasket material developed by Armstrong research. And this new Armstrong product costs considerably less than conventional asbestos materials now used in such applications.

Accopac AN-890 is made by a beater-saturated process pioneered and patented by Armstrong. This method refines the asbestos fibers and eliminates all lumps and bunches. The result is a homogeneous sheet that is tough and flexible. It die-cuts cleanly to the complex shapes often required by compressor designs.

The binder in Accopac AN-890 is a nitrile-type rubber latex. It reacts to the FREON atmosphere by swelling, and in the confined flange, this swelling actually improves the sealing efficiency of the material.

Another important advantage of AN-890 is that it maintains adequate bolt torque when tested in the presence of FREON refrigerants at temperatures commonly developed in compressors.

Accopac AN-890 is available in rolls, sheets, ribbons, or die-cut pieces. For more information and descriptive literature about this and other Accopac beater-saturated gasket materials, write Armstrong Cork Company, Industrial Division, 7003 Dean St., Lancaster, Pa.

*FREON AND COMBINATIONS OF FREON- AND F- WITH NUMERALS ARE REGISTERED TRADE-MARKS OF THE E. I. DU PONT DE NEMOURS & CO., INC., FOR ITS FLUORINATED HYDROCARBON REFRIGERANTS.

Armstrong ACCOPAC

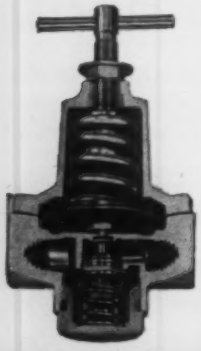
. . . used wherever performance counts

FACTS about Norgren PRESSURE REGULATORS

Norgren Pressure Regulator on punch press at Shwayder Brothers, Inc., maker of Samsonite Luggage.

Reduce Air Costs... Cut Maintenance Costs

For any air operated equipment, there is one pressure at which it is designed to operate most efficiently. Above that pressure, equipment will wear excessively with no significant increase in output, and compressed air will be wasted. No matter what the application, you can choose a Norgren Pressure Regulator that will reduce line pressure to the desired working pressure. Results will include longer equipment life, lower maintenance costs, less down-time and savings in compressed air costs.



- **Norgren Pressure Regulators are Highly Accurate** over a wide operating range.
- **Regulated Pressure is Held Constant** even with widely fluctuating line pressure and rapidly varying air flow.
- **Flow Capacity is Large**—a. Balanced valve construction; b. Large effective diaphragm area; c. Improved baffle and siphon performance; d. Large passages; e. Large valve openings.
- **Choice of Relieving or Non-Relieving Regulators.**

For complete information on all your regulator needs 1/8" to 2" inclusive, call your nearby Norgren Representative listed in your telephone directory—or WRITE FOR NEW No. 900 CATALOG.

C. A. NORGREN CO.

3442 SOUTH ELATI STREET ENGLEWOOD, COLORADO

that further research in the field may lead to tremendous increase in the thrust of conventional rocket motors.

Dr. William R. Sears, speaking at the National Academy of Sciences, said magneto-aerodynamics is concerned with the partial ionization of air as objects pass through at extremely high speeds—notably during the re-entry of rockets and satellites into the earth's atmosphere. The air ahead of the object reaches very high temperatures, due to friction and compression. Because of the extreme temperatures reached, atoms in the atmosphere release free electrons, thus making the air a conductor of electricity.

Research at Cornell shows this conductivity can be increased, said Dr. Sears, by "seeding the air near such a high-speed body with a small amount of an easily ionizable substance such as sodium or potassium. At speeds of Mach 12 to 14, a state of conductivity several times better than salt water can thus be induced."

"If this technique can be worked out, and if magnetic field strengths comparable to those of permanent magnets can be provided in flight," said Dr. Sears, "electric currents will be set up by the motion of the air, and significant forces can be applied directly to the airstream."

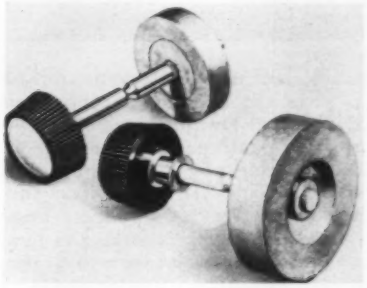
He suggested that for a satellite re-entering the atmosphere at high speed, the electromagnetic relationships will resemble those of an electric generator. The air would act as the windings of the generator armature, the electric field emitted from a satellite would appear as a generator's fixed field, and their interaction would set up an electric current. Just as torque tends to retard the armature of an operating generator, so would the air flowing past the missile tend to be decelerated. "This retarding effect," said Dr. Sears, "may prove useful in slowing down satellites to prevent their overheating as they enter the atmosphere."

Turning to the acceleration of rockets, he said that again the combination of a current and a magnetic field would give rise to a force, but that the analogy here

Circle 419 on Page 19

was that of an electric motor. If an electric field can be applied across hot, seeded air by means of electrodes, a current will flow and be directed so as to accelerate the airflow.

Said Dr. Sears, "This should provide a unique method of accelerating gases to extremely high speeds, for example in the tailpipe of a rocket. According to our studies, the speeds thus attained are theoretically unlimited. Moreover, this magneto-aerodynamics rocket can have constant cross section, and therefore can avoid some practical problems of conventional rockets."



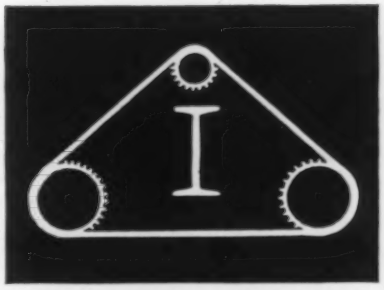
FLYWHEELS FOR TUNER KNOBS, developed by Staver Co., are made of lead alloy to provide a "heavy" feel for precise knob control of hi-fi and fine radio tuners. Available in two weights—4 oz and 8 oz—the wheels are diecast to slip over the knurled shafts of tuner knobs and hold with a press fit.

Air Force Automatic Message System Will Girdle Globe

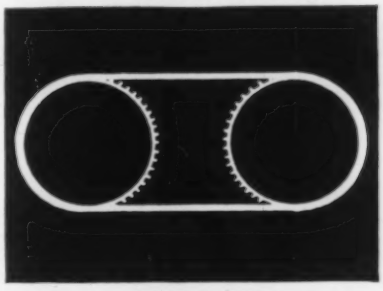
Will Replace Present 200,000-mile Network

NEW YORK—An automatic switching system has been developed for the Air Force for handling military message traffic. It is expected the new system, developed by Western Union and known as Plan 55-A, will replace the present 200,000-mile network, with push-button-operated Plan 51 centers in the U. S. and overseas.

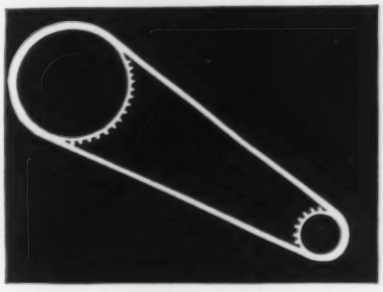
Capacity of the new private wire system will be more than three times more than that of the system used by the Air Force fol-



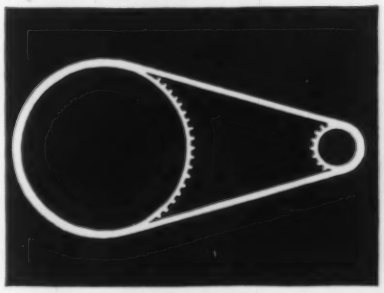
AROUND OBSTRUCTIONS



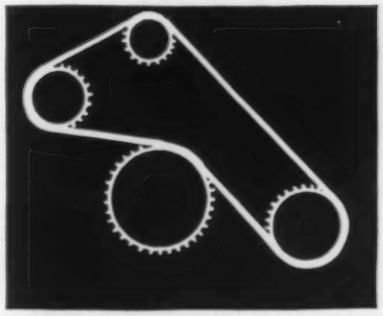
SHORT CENTERS



LONG CENTERS



HIGH RATIOS



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Is the answer to your drive problem here?

Diamond Roller Chains, Conveyor Chains and Sprockets are non-slip, adaptable precision drives. Their unusual flexibility, high strength, light weight, compactness and 98 to 99% efficiency mean they are extremely versatile and solve many drive problems easily and at low cost.

Use Diamond Roller Chains now. Capacities from fractional to thousands of horsepower, high speeds or low. Also ideal for counterweight, hoist and lift applications.

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Please refer to the classified section of your local telephone directory under the heading CHAINS or CHAINS-ROLLER

Diamond Flexible Couplings for end-to-end shaft connections to 725 H.P.

Diamond Sprockets finished bore, minimum bore and taper lock types.

Write for your copy of New Catalog 757

DIAMOND ROLLER CHAINS

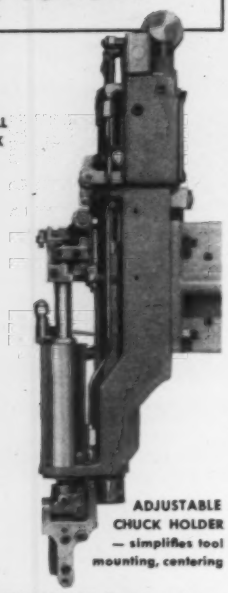
Circle 420 on Page 19

SAVE TIME AUTOMATING SMALL PARTS ASSEMBLY OPERATIONS

SPECIFY

DIXON

"Auto-Positioner"



FITS IN SMALL SPACE—21" X 3¼" X 5" DEEP

ADJUSTABLE CHUCK HOLDER — simplifies tool mounting, centering

- STANDARD HEAD DESIGN—Saves engineering time. Easy to apply to variety of jobs. Operates on ordinary 80# air pressure, 110 volts. Has machined T-slot surface, simple adjustments. Tooling, mounting column, feeders, etc., optional.
- BUILT-IN SENSING—Acts as automatic inspector, assures quality production. Machine stops if part is missing or malformed.
- FAST, VERSATILE—Handles wide range of feedable metal or plastic parts from 1/16" to 3" O.D. at speeds up to 100 cycles per minute. Easy to tool.
- PRECISION-BUILT—Sturdy frame, one-piece super-finished piston and rod, cushioned air cylinder, J.I.C. controls.
- WRITE FOR FULL DATA—New circular gives complete specifications, shows typical applications.

DIXON PARTS ESCAPEMENTS Releases single parts or in multiples at speeds up to 200 per minute. Standard models available for air, solenoid, or mechanical operation.

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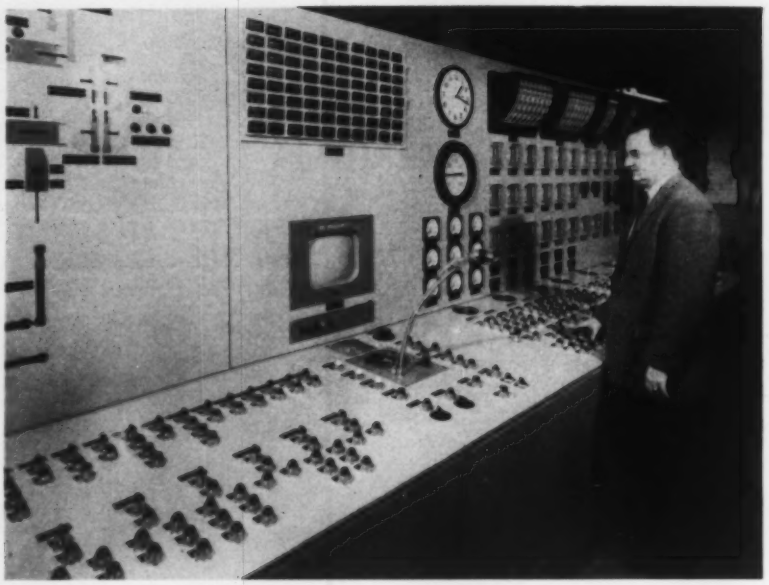
Equipment for Automatic Parts Handling and Assembly

Circle 421 on Page 19



NERVE CENTER of a new automatic sinter plant is this electronic control panel which, complete with TV screen, gives the operator a continuous picture of the end product. Designed by the Dwight-Lloyd Div. of McDowell Co. Inc. for U. S. Steel Corp., the panel permits one man to monitor all process controls for the entire sintering plant. The center section contains the intercommunication system, trouble signal devices, and controls. Rectangular panels corresponding to the various machinery lines light up in the event of a process fault, thus enabling the operator to pinpoint the source of trouble and dispatch a floor operator to correct it. The left section is designed to picture the flow of materials through the plant. The right-hand section consists of instruments which chart performance of plant elements, recording flow of raw materials, fuel consumption, product output, draft, temperatures, and other data relating to economical operation.

lowing World War II. The Air Force estimates the increased volume will be handled by 480 operators as compared with 1300 formerly required for one-third the load.

In a paper recently presented by Mr. G. S. Vernam, Western Union engineer, before the AIEE, the Plan 55-A Switching Center was said to be able to exchange traffic with switching centers using other types of switching equipment. Messages are received and retransmitted automatically in the form of perforated tape.

Routing is controlled by "routing indicators" recorded in the tape as part of the heading of each message. The form of message conforms to standards agreed upon among the Armed Services, and the switching equipment has been designed to be compatible in operation with the equipment used by the other military services.

Numerous safeguards and alarms are provided throughout the system to prevent errors, avoid delays, and guard against lost messages.

Meetings

AND EXPOSITIONS

March 17-20—

American Society of Mechanical Engineers. Aviation Div. Conference to be held at the Statler-Hilton Hotel, Dallas. Additional information can be obtained from ASME headquarters, 29 West 38th St., New York 18, N. Y.

March 17-21—

National Association of Corrosion Engineers. Fourteenth Annual Conference and Exhibition to be held at the Civic Auditorium, San Francisco. Further information is available from association

NOW

for the first time

LOW COMPRESSION SET

Butyl "O" RINGS

NEW

Another LINEAR first . . . a new, low compression-set Butyl Compound for use in "O" Rings. LINEAR Butyl Compound 7806-70 is a seal material that withstands compression set at elevated temperatures without being permanently deformed or losing its resiliency and its value as a seal. Also, Butyl withstands the chemical actions of the non-flammable phosphate esters such as "Skydrol", "Pydraul" and "Cellulube."

YET, PROVEN

Exhaustive tests, under method "B" of the ASTM, show this new LINEAR compound develops only 30 to 40% compression set after 70 hours at 212°F, as compared to the usual 70 to 95% set experienced with previous Butyl compounds. This unusually good resistance to permanent deformation, combined with a tensile strength of 2000 psi and an elongation factor of 275%, make this material an outstanding one for all "O" Ring applications and other molded shapes where Butyl rubber's excellent qualities are desirable.

Whenever you have a seal problem that is tough to handle—look to LINEAR for an answer. Write, or ask the local representative for complete information on LINEAR's new Butyl Compound 7806-70—today.

"PERFECTION IN RUBBER"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA

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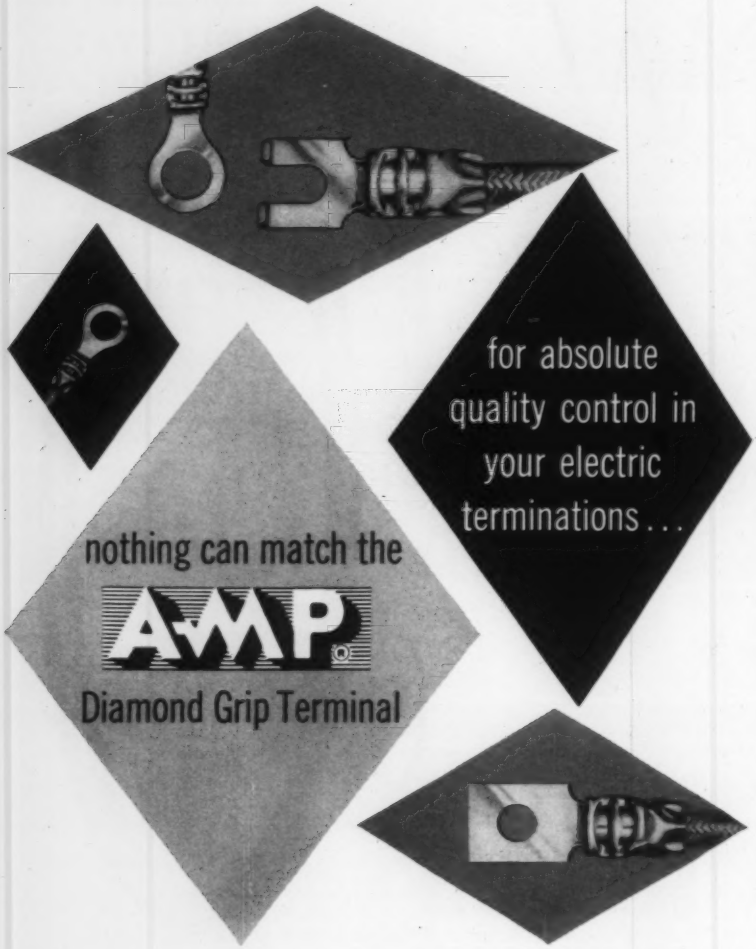


An endless parade of electrically perfect, wired terminals with absolutely identical performance characteristics is assured when A-MP non-insulated Diamond Grip terminals are used. No matter how many terminals you need, each action of the A-MP precision tool attaches a Diamond Grip terminal that gives firm, fully circumferential wire support, for maximum tensile strength, resists vibration and corrosion, while performing at maximum conductivity.

The reason for these never-varying features is the exact crimping operation which pressures the wire into one homogeneous mass and permanently bonds it to the terminal. Wire size range is from No. 26 to No. 10. Important, too, are the lower installed costs of Diamond Grip terminals when compared to other methods of wire termination.

No matter what your termination problem is, our engineering services are available to you anywhere in the free world.

For complete specifications, write for our Diamond Grip Terminal and Connector catalog.

AMP INCORPORATED

General Offices: Harrisburg, Pennsylvania

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

Circle 423 on Page 19

headquarters, 1061 M & M Bldg., Houston 2, Tex.

March 17-21—

1958 Nuclear Congress, to be held in conjunction with the Atomfair of the Atomic Industrial Forum at the International Amphitheatre, Chicago. More than 30 organizations sponsor the Congress, which is co-ordinated by the Engineers Joint Council, 29 W. 39th St., New York 18, N. Y.

March 19-20—

American Society of Mechanical Engineers. Engineering Management Conference to be held at the Somerset Hotel, Boston. Further information is available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

March 24-27—

Institute of Radio Engineers. National Convention to be held at the Waldorf-Astoria Hotel and the Coliseum, New York. Additional information can be obtained from IRE headquarters, 1 E. 79th St., New York 21, N. Y.

March 26-28—

20th Annual American Power Conference to be held at the Hotel Sherman, Chicago. Conference is sponsored by Illinois Institute of Technology in co-operation with 14 other colleges and universities and nine technical societies. Additional information can be obtained from Dr. E. R. Whitehead, Electrical Engineering Dept., Illinois Institute of Technology, Chicago 16, Ill.

March 31-April 2—

Society of Automotive Engineers. Production Meeting and Forum to be held at the Drake Hotel, Chicago. Further information is available from society headquarters, 485 Lexington Ave., New York 17, N. Y.

April 1-3—

American Society of Mechanical Engineers. Instruments and Regulators Conference to be held at the University of Delaware, Newark, Del. Further information can be obtained from ASME, 29 W. 39th St., New York 18, N. Y.

April 8-11—

Society of Automotive Engineers. Aeronautic Meeting, Aeronautic Production Forum and Aircraft Engineering Display to be held at the Hotel Commodore, New York. More information can be obtained from society headquarters, 485 Lexington Ave., New York 17, N. Y.

April 14-17—

Design Engineering Show to be held at the International Amphitheatre, Chicago. Design Engineering Conference, sponsored by the Machine Design Div. of ASME, will be held in conjunction with the show. Additional information is available from Clapp & Poliak, 341 Madison Ave., New York 17, N. Y.

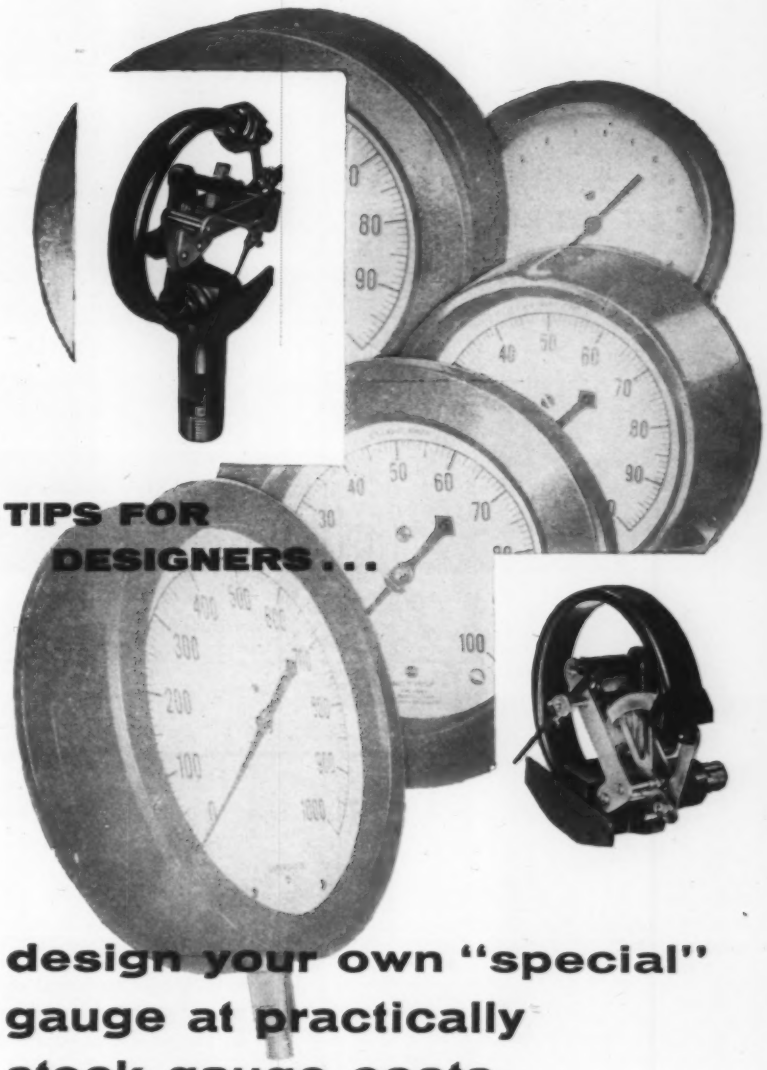
April 14-18—

American Welding Society. National Spring Meeting to be held in St. Louis. The show will be held at Kiel Auditorium April 15-17; technical sessions will be presented at Hotel Statler April 14-18. Further information can be obtained from AWS headquarters, 33 W. 39th St., New York 18, N. Y.

April 20-24—

Scientific Apparatus Makers Association. 40th Annual Meeting to be held at the El Mirador Hotel, Palm Springs, Calif. Additional information is available from association headquarters, 20 N. Wacker Dr., Chicago 6, Ill.

"Where'd we get this new operator?"



TIPS FOR DESIGNERS . . .

design your own "special" gauge at practically stock-gauge costs

Before you specify an expensive special gauge, check your requirements with USG. Available to you are 50,000 different standard gauges. With slight modification, many of these will meet special design problems.

USG saves manufacturers thousands of dollars annually by making possible "special" gauge designs from standard components. For help with your gauge problems call or write the factory today.

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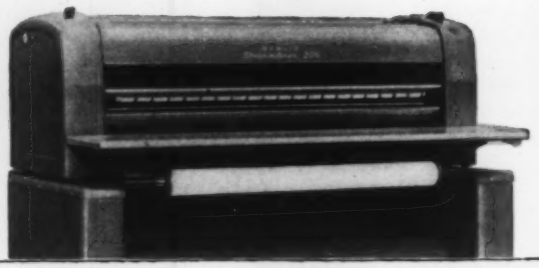
MORE THAN 50,000 TYPES OF GAUGES • SUPERGAUGES • SOLID FRONT GAUGES • RECEIVER GAUGES • TEST GAUGES • RECORDERS • CONTROLLERS • TRANSMITTERS • PSYCHROMETERS • AVIATION INSTRUMENTS

Circle 424 on Page 19

How to make design changes in minutes . . . and cut drafting costs, too



There's no more need to bog down drafting operations with time-wasting tracing or redrawing of your original design.

Now with Ozalid intermediate materials, you can make design changes quickly, neatly, easily. Ozalid intermediates give you exact duplicate originals that can save you *hours* of drafting time. Specific detail changes are as simple as 1–2–3. Just make an Ozalid intermediate print . . . on film, translucent paper, or cloth . . . and remove obsolete details with Ozalid Corrector Fluid. If you prefer, unwanted details can be removed by "scissor-editing" or the "lock-out" method. Next, draw in your new design and you've got a new, up-to-date original . . . all ready for running prints.

And with the convenience of the *table model* Ozalid Streamliner 200, you can run prints off in seconds . . . *full 42" width* prints that are yours at *low cost*. No more waiting for prints. Now *anyone* in your office can turn out sparkling whiteprints on-the-spot.

But why not see for yourself? Call your local Ozalid representative or write: Ozalid, Dept. S-3-6, Johnson City, N. Y.

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First Name in Whiteprinting

A Division of General Aniline & Film Corporation
In Canada: Hughes Owens Company, Ltd., Montreal

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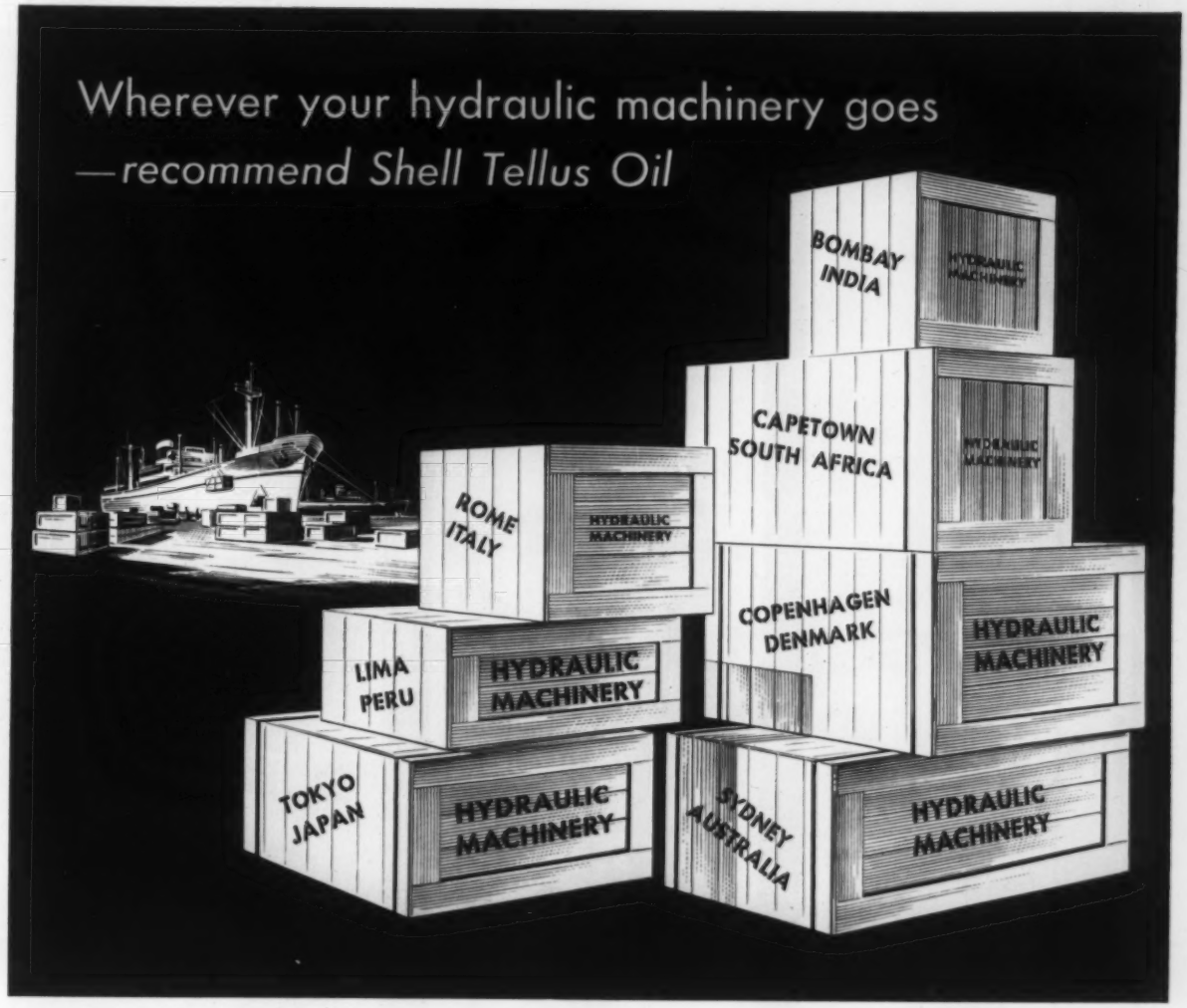

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Shell Rimula Oils—for heavy-duty diesel engines

Shell Talona R Oil 40—anti-wear crankcase oil for diesel locomotives

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Shell Turbo Oils—for utility, industrial and marine turbines

Shell Dromus Oils—soluble cutting oils for high-production metal working

Shell Macoma Oils—for extreme pressure industrial gear lubrication

Shell Voluta Oils—for high-speed quenching with maximum stability

Shell Tellus Oil is top-rated as both a lubricant and a control fluid for complex hydraulic systems. Its ability to combat oxidation, rust, sludge-formation, wear and foaming has earned it nationwide popularity.

You may be glad to know that the hydraulic-operated equipment you manufacture can now obtain the same efficient protection in other countries of the world. Tellus* Oil is available to your customers abroad. With it they can enjoy the same performance that your domestic customers rely upon.

For more complete information on Tellus Oil, write Shell Oil Company, 50 West 50th Street, New York 20, New York, or 100 Bush Street, San Francisco 6, California.

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SHELL TELLUS OIL

SHELL

Circle 426 on Page 19

Miracle Plant! Zoospores of some fungus cover their own length as fast as a Sabrejet. The bacterium *Pseudomonas aeruginosa* (shown many times its size) has been clocked at 31.7 lengths per second. To do as well, proportionate to size, a man would have to run 125 miles an hour.

Miracle Instrument. This anemometer catches a puff of wind wafting less than 1 mile per hour. Its high sensitivity and accurate measurement of wind speed are aided by two MPB bearings in which the shaft rests. Quick starting is result of low initial torque.

Man With Miracles. This is Nick Carter, MPB's Chief Engineer. He helped the anemometer people find exactly the right type of radial retainer bearing that would reduce friction to a minimum, give failure-proof service and help keep original and maintenance costs low.

Miracles in Miniaturization

ACTUAL SIZE

New Age Of Miracles is miniaturization in industry. It's a new frontier as magnificent as the colossal. With MPB bearings the impossible miniaturization often becomes practical; the pretty-good becomes perfect. MPB has the greatest wealth of experience in miniaturization in the bearing industry . . . over 500 types and sizes available . . . specials on request . . . technical assistance and research facilities second to none. You'll want to know more about the subject. For our new catalog write **Miniature Precision Bearings, Inc.,** 103 Precision Park, Keene, N. H.

MPB

Helps you perform miracles in miniaturization

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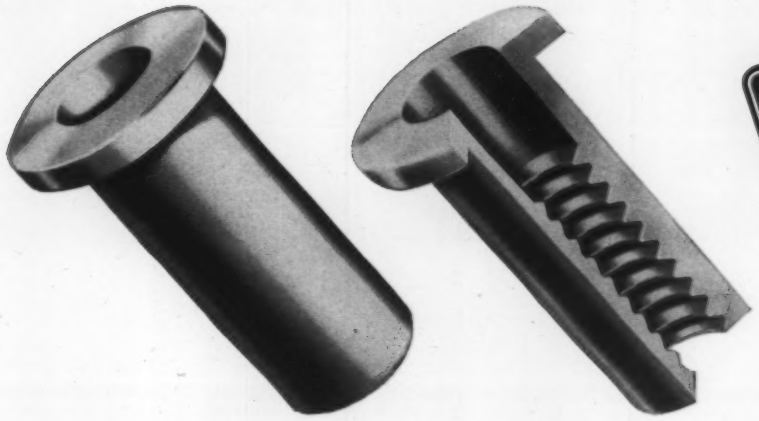
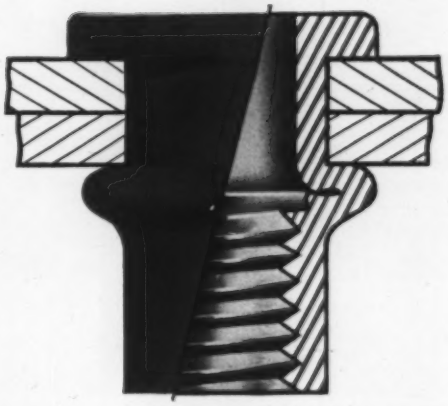


B.F.Goodrich

B. F. Goodrich Rivnuts®–the only one-piece blind fasteners with threads



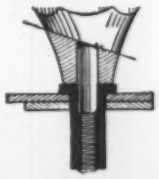
If you have a fastening problem, solve it the easy way—with B.F.Goodrich Rivnuts. One man can install Rivnuts from one side of the work. It takes only a few seconds—speeds assembly and cuts costs as much as 50 to 90% depending upon the application.

Rivnuts are stronger, too, because they provide at least 6 clean threads, even in thin sheet metal. By eliminating welding, tapping and cleaning, B.F.Goodrich Rivnuts eliminate costly steps in production and straighten out assembly lines.

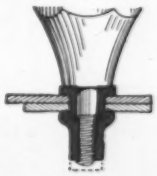
Rivnuts come in a variety of types, sizes and materials to solve your specific fastening problem, whether you are working with sheet metal, wood or plastic. For complete information, send for the free Rivnut Demonstrator. It shows with motion how Rivnuts fasten *to* and *with*. Write: B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Dept. MD-38, Akron, Ohio.

Rivnuts provide at least 6 clean threads in one simple operation

1 Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



2 Rivnut is inserted—head firmly against work—tool at right angles to work.



3 Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.

4 After upset, Rivnut threads are still clean and intact ready for screw attachment.

B.F.Goodrich aviation products

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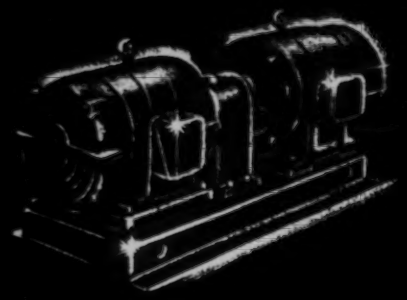
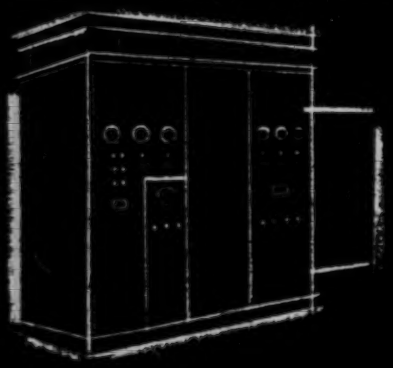
1 Precise high-frequency drives for generators or converters



Because of its exact speed characteristic, the Syncro-Spede is an ideal driver for high-frequency generator sets where precise frequency is a necessity. The elimination of slip provides exact frequency throughout the entire load range of the motor.

2 Precise timing, metering, and recording devices

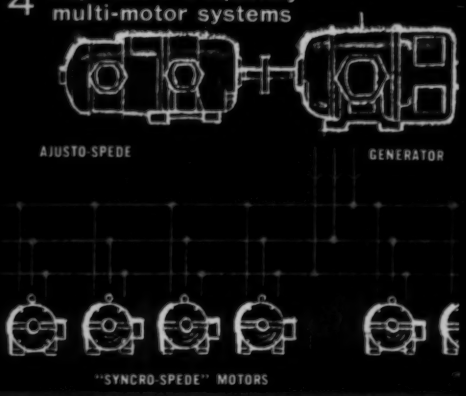


Syncro-Spede delivers and maintains exact synchronous speed within rated capacity regardless of load or line voltage dips. Its design permits mechanical modifications to meet special needs. Since it eliminates error caused by speed fluctuations, this new Louis Allis motor is also ideal for memory drums and precision timing devices.

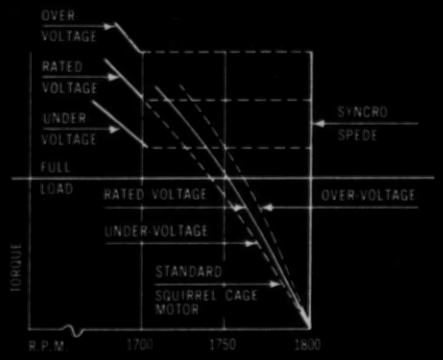
3 Constant single- or multi-speed conveyor drives

Syncro-Spede gearmotors can provide exact constant conveyor speed—or maintain correct relation of several conveyors operating at different speeds. Used with Louis Allis gear drives, the Syncro-Spede offers a practical, low-cost solution to low-speed conveyor drive requirements—down to 7.5 rpm.

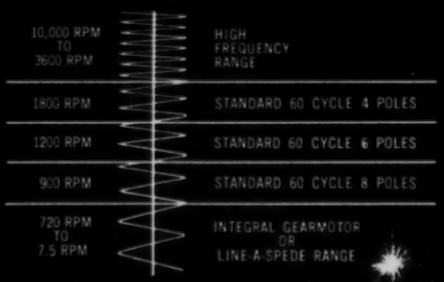
4 Adjustable frequency multi-motor systems



5 Any constant speed requirement



6 High speed—high frequency operation



Below values are typical values based upon 100% pull-in torque with the external inertia equal to no more than twice the rotor inertia. To obtain full load and locked amps for other standard low voltages, multiply below 220 volt values by the inverse ratio of the voltages. For applications with high external inertias, refer to factory with specific inertia values.

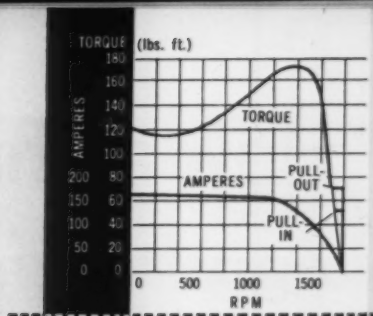
HP	Synch. RPM	Frame Size	Full Load Amps 220 V.	% Locked Rotor Torque	Locked Amps 220 V.	Full Load Power Factor	Full Load Efficiency	Rotor WK²
1	1800	182	4.4	275	30	59	76	.18
	1200	184	4.6	200	30	58	75	.22
1.5	1800	184	6.6	265	41	59	76	.18
	1200	184	7.0	200	41	58	75	.24
2	1800	184	7.7	250	58	64	82	.22
	1200	213	8.3	200	58	62	78	.49
3	1800	213	11	250	83	67	82	.49
	1200	215	14	200	83	61	78	.80
5	1800	215	17	200	120	68	85	.80
	1200	254U	21	175	120	61	82	1.30
7.5	1800	254U	25	200	170	68	86	1.30
	1200	256U	28	175	170	62	83	1.80
10	1800	256U	34	200	240	68	85	1.80
	1200	284U	36	175	240	63	83	3.50
15	1800	284U	49	200	330	70	86	3.0
	1200	326U	54	165	330	63	84	5.50
20	1800	286U	63	200	420	70	87	5.00
	1200	326U	65	150	420	64	85	5.50
25	1800	324U	79	200	520	70	87	6.0
30	1800	326U	95	200	700	70	88	7.0

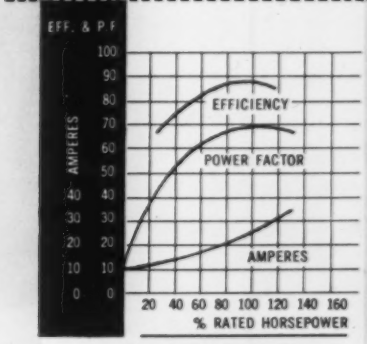
Syncro-Spede motors of different ratings and output speeds can be synchronized from a single adjustable frequency source — motors of various speeds will hold their exact relationship within an operating frequency range of 5 to 1,000 cycles. This combination provides precise adjustable frequency power for many applications in the printing, paper, plastic, and textile industries.

The Syncro-Spede offers virtually unlimited usage. It is much smaller than equivalent reluctance and DC excited synchronous motors—outperforms both and costs less. Under full load conditions, a standard squirrel cage induction motor may vary between 1740 and 1760 rpm with a 10% voltage variation — the Syncro-Spede maintains exact synchronous speed.

Syncro-Spede's indestructible cast aluminum rotor is designed for high-speed — high frequency operation. The small diameter rotor enables the motor to attain speeds previously impossible with other types of synchronous motors. With special rotor designs, the Syncro-Spede can reach speeds of 10,000 rpm and higher.

New-product news from Louis Allis





IMPROVED PERFORMANCE DATA

The Louis Allis Syncro-Spede

...a synchronous motor built in the same NEMA frames as standard motors of equal horsepower!

It's compact, simple, versatile... and trouble-free!

The remarkable Louis Allis Syncro-Spede® Motor enables you to provide exact synchronous speed for *any* application for less cost — with fewer controls — and in less space than previously possible.

If your equipment or operation calls for precise constant speed, check the advantages this new motor offers you:

Space-saving design — The revolutionary Syncro-Spede needs no external excitation, wound rotating fields, collector rings or brushes. It's built in the same standard NEMA frames as ordinary induction motors of equal horsepower. It requires less space — is virtually maintenance-free.

Wide range of enclosures — The Syncro-Spede can be provided in a wide variety of enclosures to meet special operating requirements. For example, Syncro-Spede is readily available in totally-enclosed fan-cooled and explosion proof enclosures — thus permitting installations which were difficult to make with D.C. excited synchronous motors.

Unmatched versatility — Syncro-Spede is available in standard sizes up to 100 hp, and even larger ratings for special applications. It can also be furnished in a wide range of mechanical modifications . . . base- or flange-mounted — as a gearmotor or brakemotor — even as a rolled-shell shaftless motor for "built-in" applications.

For full particulars and expert application engineering help, contact your local Louis Allis District Office. Or write for Bulletin No. 1900 to The Louis Allis Co., 459 East Stewart Street, Milwaukee 1, Wisconsin.

Syncro-Spede is a Trademark of The Louis Allis Company

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

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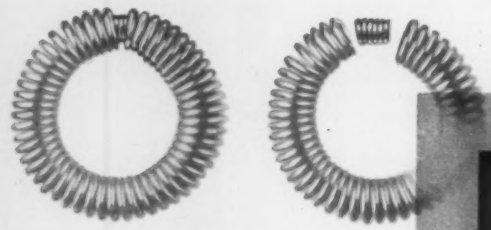
LA-140

LOUIS ALLIS

How a change in spring design can reduce cost and improve performance.



FIRST DESIGN

IMPROVED DESIGN

In the original conception of this switch retaining spring, an extension spring was formed into a garter spring by inserting a small plug in the form of a spring into the two ends. Assembly operation proved difficult and costly.

In the redesigned spring, one end is reduced in diameter and inserted into other end, eliminating the spring plug and providing stronger unit.

Early consultation with our spring specialists, following the determination of fundamental performance characteristics, is often insurance against unnecessarily complicated manufacture. Write for pamphlet "How to solve your spring problems." Gives case histories and valuable design considerations for various types of springs.

Associated Spring Corporation

General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
B-G-R Division, Plymouth and Ann Arbor, Mich.
Seaboard Pacific Division, Gardena, Calif.
Cleveland Sales Office, Cleveland, Ohio
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Wallace Barnes Steel Division, Bristol, Conn.
Canadian Subsidiary: The Wallace Barnes Co., Ltd., Hamilton, Ontario and Montreal, Quebec

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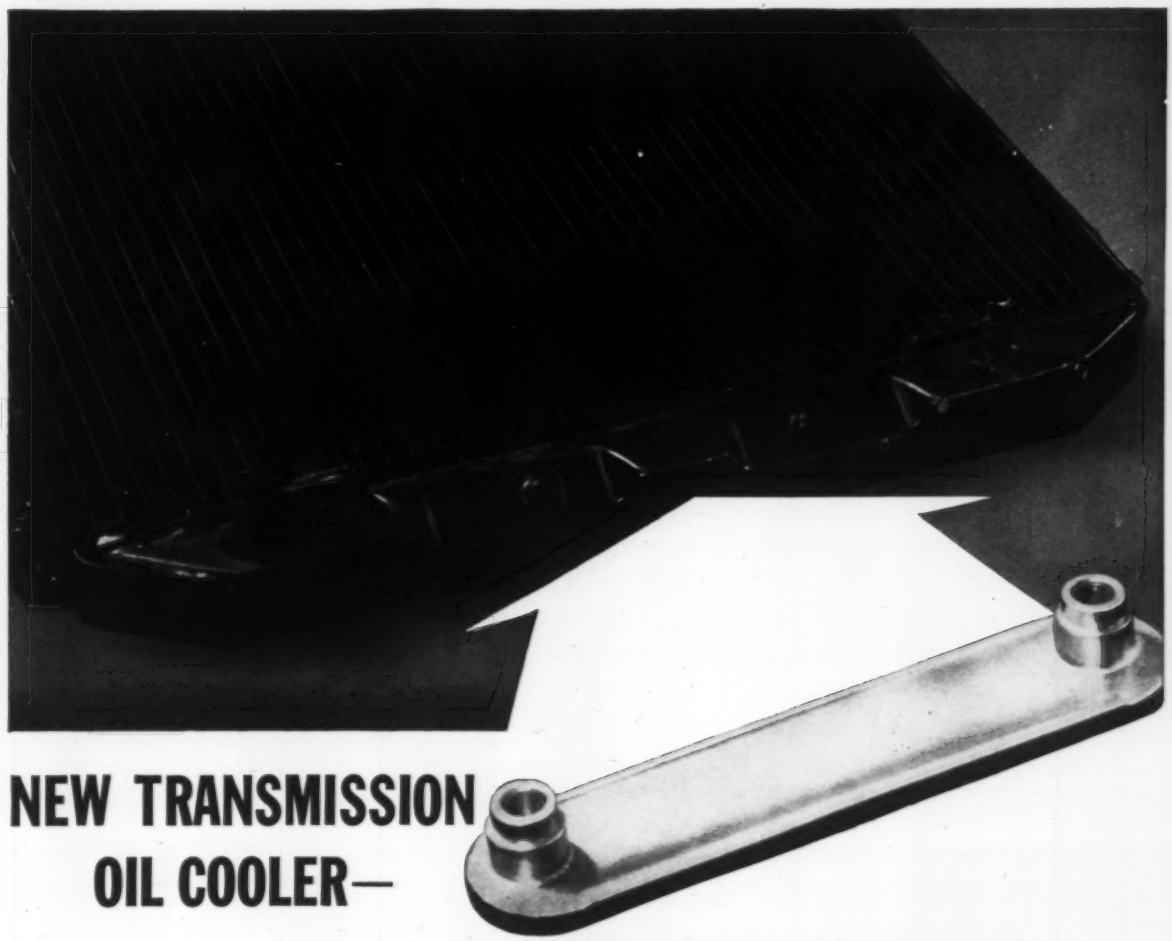


NEW TRANSMISSION OIL COOLER— another First for ALLEGHENY STAINLESS

Over 70% of today's cars are powered with automatic transmissions. Fine for the motorist, but new problems for the designer. Transmission oils zoom to 300 degrees and must be cooled.

Solution? Mount a small, efficient heat exchanger within the lower tank of the radiator, as shown above. Make it able to stand wide temperature differentials—surrounding cooling water from 0° to 180°; searing oil of 300°. Make it corrosion proof—against all types of water, all varieties of anti-freeze compounds, dirty, hot oil. Since it's tucked inside the radiator, make it strong and maintenance-free.

Allegheny 430 Stainless Steel has proved itself to meet all these design objectives. And it actually reduced unit cost over other materials while still improving performance. The ductility and corrosion resistance of this straight chromium stainless make it a natural for this type of application.

Perhaps *your* product could be improved by a switch to Allegheny 430. It costs less than chromium-nickel stainless grades, it's always readily available, not subject to nickel shortages. To find out how Allegheny 430 Stainless can help you, write for the Technical Bulletin described below or call the Allegheny Ludlum Sales Office nearest you.

Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.

WSW 6782

Write for this 16-page Technical Study that describes alternate selections available for the Chrome-Nickel Stainless Steels. Gives properties, fabrication data, etc.

ADDRESS DEPT. MD-3

Make it BETTER and LONGER LASTING with

ALLEGHENY STAINLESS

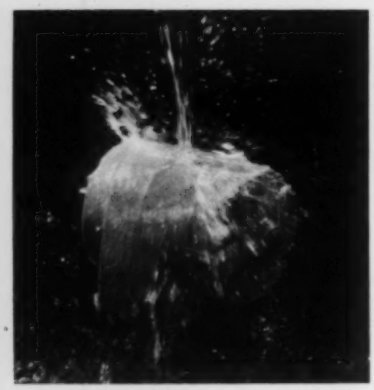
Warehouse stocks carried by all Ryerson steel plants

AL

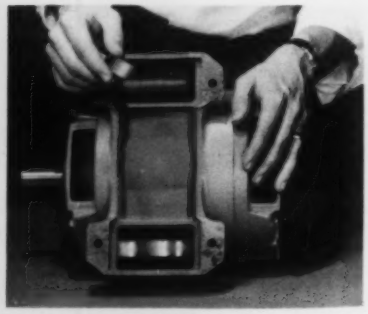
Circle 432 on Page 19

Circle 433 on Page 19→

Get faster assembly–more dependable

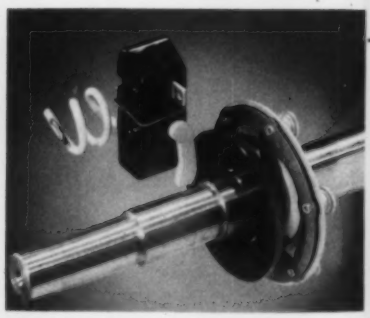


Better Protected against dripping or splashing liquids, this G-E motor is suitable for many jobs where an ordinary dripproof motor cannot be applied.



Base-mounted Capacitors eliminate bulky capacitor "top hat," are safe from physical damage. Easy-to-remove spring clips hold capacitors in place.

Perma-Numbered Leads are always easy to identify. Non-wicking neoprene insulation prevents moisture from running up leads into vital parts.



Totally-enclosed Transfer Switch assures positive contact and long life—over 1,000,000 consecutive operations on test.

operation for your products . . .

WITH GENERAL ELECTRIC TRI 55 CLAD SINGLE-PHASE MOTORS

HERE'S WHY:

Perma-numbered leads in the G-E Tri/Clad '55' motors make connection easier because they are easy to identify. Threaded conduit entrance eliminates need for internal lock nut . . . faster installation results. And rigid cast-iron frame and endshields prevent motors from being twisted out of line during assembly operations—make machine operation more dependable.

THE SMALL SIZE AND LIGHT WEIGHT of Tri/Clad '55' standard motors facilitates installation on your products; helps reduce mounting and shipping costs *without* sacrificing full-power performance. Also, G.E.'s dripproof design allows these single-phase motors to be used for many applications which normally require splashproof type motors . . . you save money.

FOR LONGER MOTOR LIFE, G-E Tri/Clad '55' motors feature Mylar* polyester film insulation, Formex† magnet wire, water-resistant stator coating, and better physical protection. Longer motor life, of course, results in longer life and increased dependability for your products.

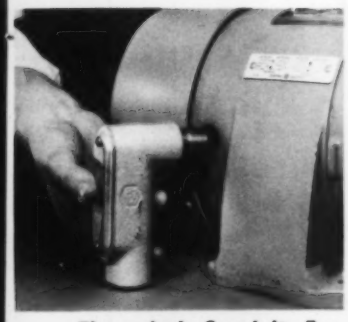
COMPARE G-E Tri/Clad '55' motors with other makes of motors. Remember: (1) General Electric offers you a complete line of single-phase motors to choose from . . . dripproof or enclosed, vertical or horizontal, C-face or D-flange, all of which meet NEMA standards. (2) You'll also be pleased with the ***exceptionally*** fast delivery you can get and with G.E.'s small motor service station plan . . . a real plus in cementing customer relations.

CONTACT your local G-E Apparatus Sales Office now for personal proof of how these G-E motors can help cut your costs, reduce assembly time, and give longer-life operation. And ask for your free copy of illustrated bulletin GEA-6240, or write Section 840-18, General Electric Company, Schenectady 5, New York.

*Registered Trade-mark of DuPont Co.

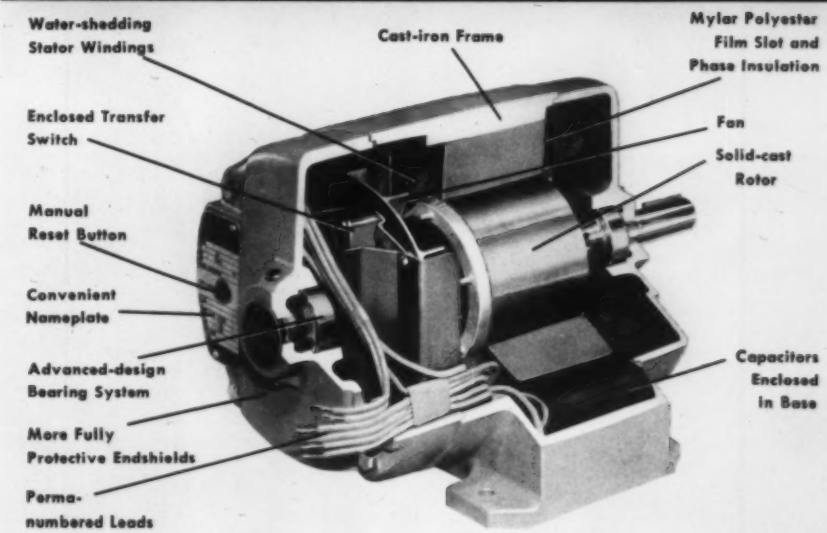
†Registered Trade-mark of General Electric Co.

GENERAL ELECTRIC



Threaded Conduit Entrance permits quick, easy installation; provides tighter, dust-proof seal for conduit.

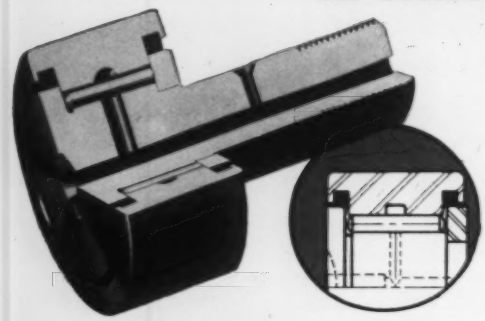
SINGLE-PHASE TRI CLAD MOTORS OFFER THESE TIME AND MONEY SAVING FEATURES



Standard single-phase Tri/Clad '55' motor

BEARING TIPS by McGill

sealed CAMROL® bearings lock out contamination in critical cam follower applications

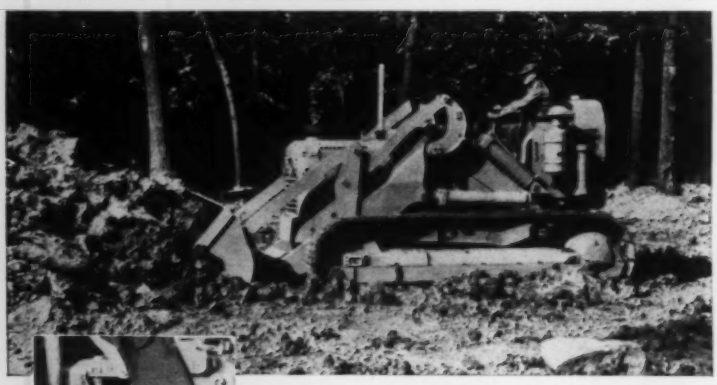


Now Sealed and Prelubricated

The new SCF series of the famous CAMROL cam follower completely seals out dirt, chips, moisture, etc. — an important advantage where the life of an ordinarily open mounted cam follower can be materially increased with adequate protection against contamination. Also the sealed bearing is pre-lubricated with provision made for easy re-lubrication, if desired, through either end of the stud.

Specially treated synthetic seals are contained in the outer race undercuts over the stud flange and roller retaining washer. For added protection, all external surfaces of the bearing are treated to provide a corrosion resistant, black ferrous oxide surface.

These same advantages are available in the SCYR sealed series Cam Yoke Roller (without stud). Specify CAMROL bearings with the built-in seals that preserve cam follower dependability in critical cam action, support or track roller application.



Built-in seals protect and preserve CAMROL® bearings from contamination in CATERPILLAR-built TRAXCAVATORS®

McGill SCF series sealed CAMROL bearings provide the cam action that positions the bucket of the No. 977 Traxcavator unit at the selected digging angle. Mounted on bell crank arms that are actuated by contact with a cam shoe on a hydraulic cylinder linkage, these bearings are operating in the open and exposed constantly to dust, dirt and moisture. External surfaces have a black ferrous-oxide finish to prevent corrosion. These sealed McGill cam followers eliminate the need for relubrication and maintenance after installation. Caterpillar uses other McGill bearings including twelve CYR series cam yoke roller bearings in the flywheel clutch.

378 sealed CAMROL® bearings guide engine blocks in INGERSOLL automatic milling machine

The sealed CAMROL bearings used in this machine, guide cylinder blocks during transfer through various milling, boring and drilling operations. The bearings, used in place of guide bars, eliminate surface scratching of the 200 to 300 pound blocks which are transferred at speeds up to 400 feet per minute. Blocks are processed at the rate of 95 per hour. Ingersoll reports freer movement, accuracy of positioning and materially longer bearing life due to the new design that seals metal chips out of the bearings.

Insure performance with McGILL®

MULTIROL® GUIDEROL® CAMROL®
Precision Needle Bearings

McGILL MANUFACTURING COMPANY, INC., 200 N. LAFAYETTE ST., VALPARAISO, INDIANA

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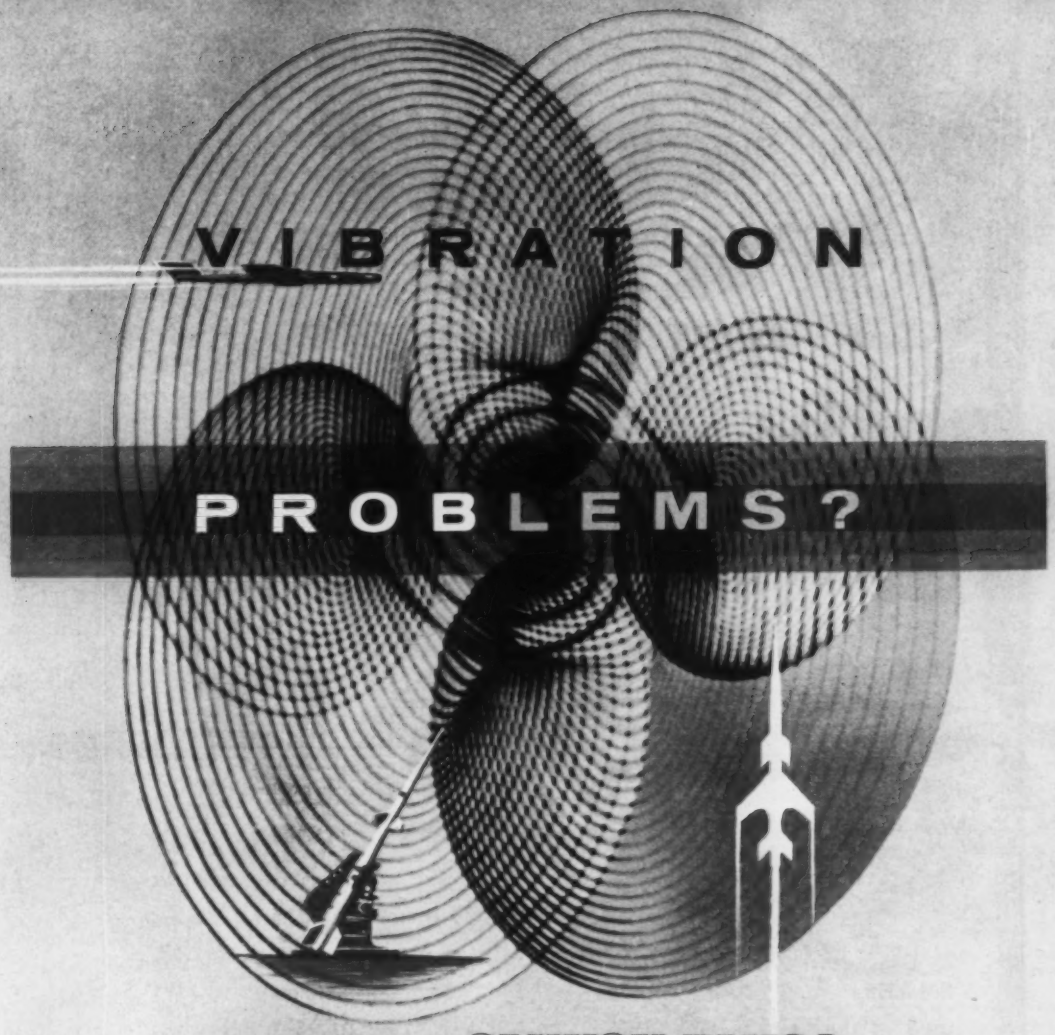
VIBRATION PROBLEMS?



CALL OUT CANNON PLUGS

Improvements are constantly being made in Cannon connectors to give you maximum reliability in circuitry under constantly increasing highly critical vibration conditions. New lines . . . improvements on the MS-E design . . . include the EX, the CT, the EA, and the EB Series.

You'll find Cannon vibration and moisture-proof resilient-insert lines extensive and complete, in hundreds of carefully designed layouts. Interfacial sealing. Improved grommets and grommet followers. Styles with extra strong coupling nuts. Telescoping rubber bushings. Strong clamps. Means for safety wiring. Grounding lugs. Every facility to give solutions to vibration, moisture condensation, flashover, and corona problems.

Vibration-proof Series include MS-E, CA-F, EA, EB, EX, and CT. Write TODAY for full information.

MS-E (Series CT)
Socket Assembly
Ask for
MS-E Catalog

CA 3100 F
Wall Mounting Receptacle
Ask for
AN/MS Catalog

MS-E (Series ME)
63 Inserts Available
Ask for
MS-E Catalog

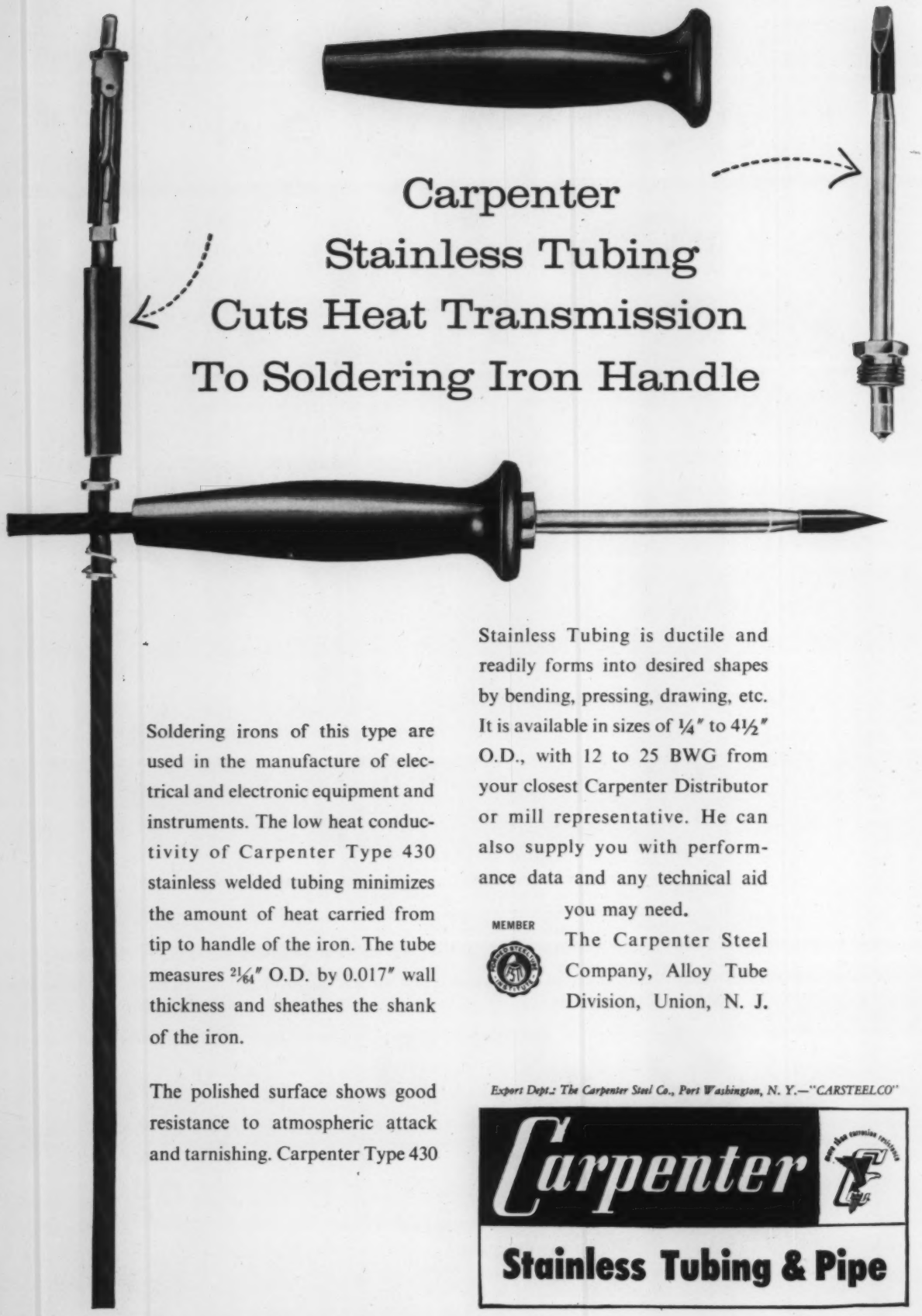
EX 06
Plug Assembly
Ask for
EX Catalog

CANNON PLUGS
WHERE RELIABILITY IS THE 5TH DIMENSION

Write for 44-page, 2-color Plug Guide, Bulletin CPG-3

Please Refer to Dept. 120

CANNON ELECTRIC CO., 3208 Humboldt St., Los Angeles 31, Calif. Factories in Los Angeles, Salem, Mass., Toronto, Melbourne, London. Manufacturing licensees in Paris and Tokyo. Representatives and distributors in all principal cities.



Carpenter Stainless Tubing Cuts Heat Transmission To Soldering Iron Handle

Soldering irons of this type are used in the manufacture of electrical and electronic equipment and instruments. The low heat conductivity of Carpenter Type 430 stainless welded tubing minimizes the amount of heat carried from tip to handle of the iron. The tube measures 21/64" O.D. by 0.017" wall thickness and sheathes the shank of the iron.

The polished surface shows good resistance to atmospheric attack and tarnishing. Carpenter Type 430 Stainless Tubing is ductile and readily forms into desired shapes by bending, pressing, drawing, etc. It is available in sizes of 1/4" to 4 1/2" O.D., with 12 to 25 BWG from your closest Carpenter Distributor or mill representative. He can also supply you with performance data and any technical aid you may need.

MEMBER

The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

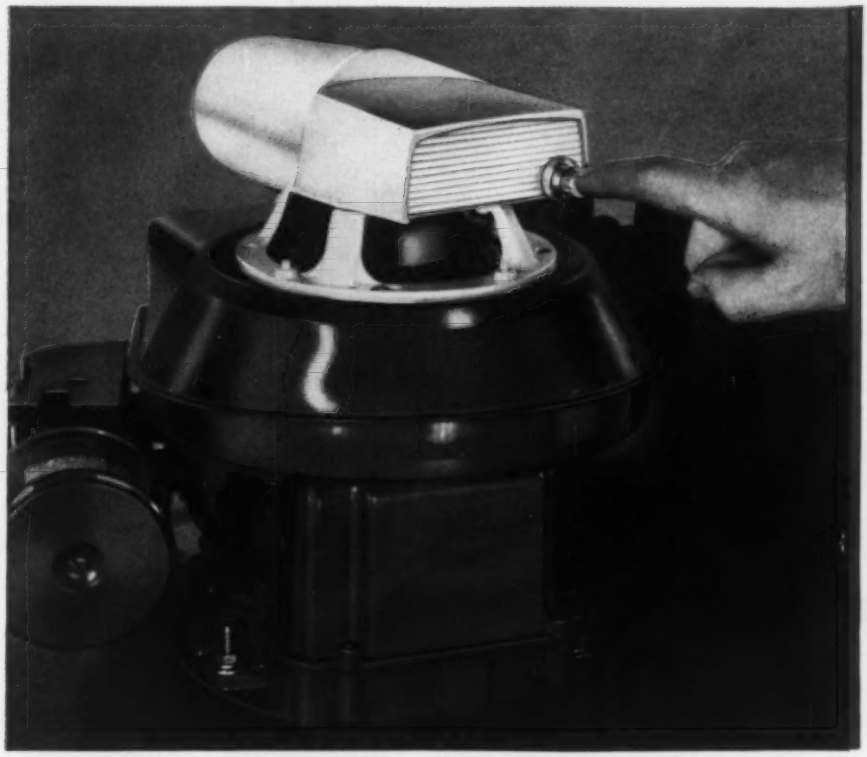
Carpenter

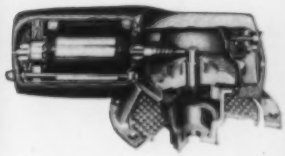
more than corrosion resistance

Stainless Tubing & Pipe

Circle 436 on Page 19

NOW Pushbutton starting packaged for gasoline engines up to 4hp





Compact gearing gives fast, dependable action, attractive silhouette. Same mounting as for conventional rewind starter.

Remote pushbutton switch can be installed at any convenient location . . . makes mowers and mobile industrial equipment a pleasure to operate.

NEW MODEL 850 FAIRBANKS-MORSE ELECTRIC STARTER, operated by 12-volt battery, *fits right on your present engine* to extend sure-fire pushbutton starting to gasoline engines up to 4 hp. Clutch mechanism is same design as for your present rewind starter. Performs equally well in all positions. Add this important timesaving and trouble-ending advantage to your equipment *now* and watch the fast response of your customers!

Remote pushbutton switch can be installed at any convenient location to make riding mowers and mobile industrial equipment easier and more pleasant to operate.

Enthusiastic response to a kit offer in *Better Homes and Gardens* proves consumer public wants this pushbutton starter on power mowers and other small engines.

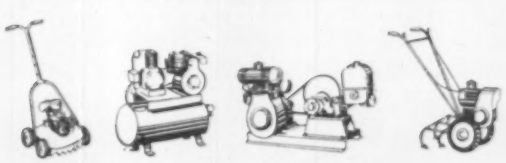
Opens the way to the addition of lights and other power accessories on your equipment.

Snowballing recognition by gasoline-engine-powered equipment manufacturers and demand by users are rapidly making Fairbanks-Morse Electric and Rewind Starters standard equipment on *all types* of gasoline engines. Send coupon below for complete facts and features on the trend-setting Fairbanks-Morse line.

FAIRBANKS-MORSE

A name worth remembering when you want the BEST

MAGNETOS • REWIND AND ELECTRIC STARTERS • WATER SYSTEMS • GENERATING SETS • PUMPS • MOTORS • SCALES • DIESEL LOCOMOTIVES AND ENGINES



FASTER, EASIER STARTING FOR SMALL GASOLINE ENGINES

READ about the world's most complete line of rewind and pushbutton starters. Cutaway photos, detail drawings, specifications, application charts.

Fairbanks, Morse & Co.,
Magneto Division
Beloit, Wisconsin

Name_____

Company_____

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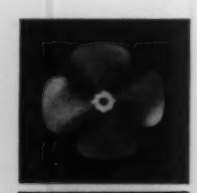
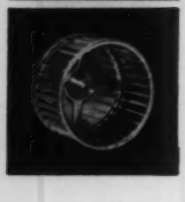
City_____ State_____

Circle 437 on Page 19

Torrington technology,
tools and testing facilities
have already solved upward
of half a million different details
in the design problems
of air impellers for industry.

This means that Torrington
is literally tooled up and ready to run
on practically any air impeller
requirement you may have.
It means also that Torrington—where
engineers work only *on air moving problems*
—has a tremendous head start in meeting your most
difficult and cost-critical specifications for
advanced product development
...Talk to Torrington!

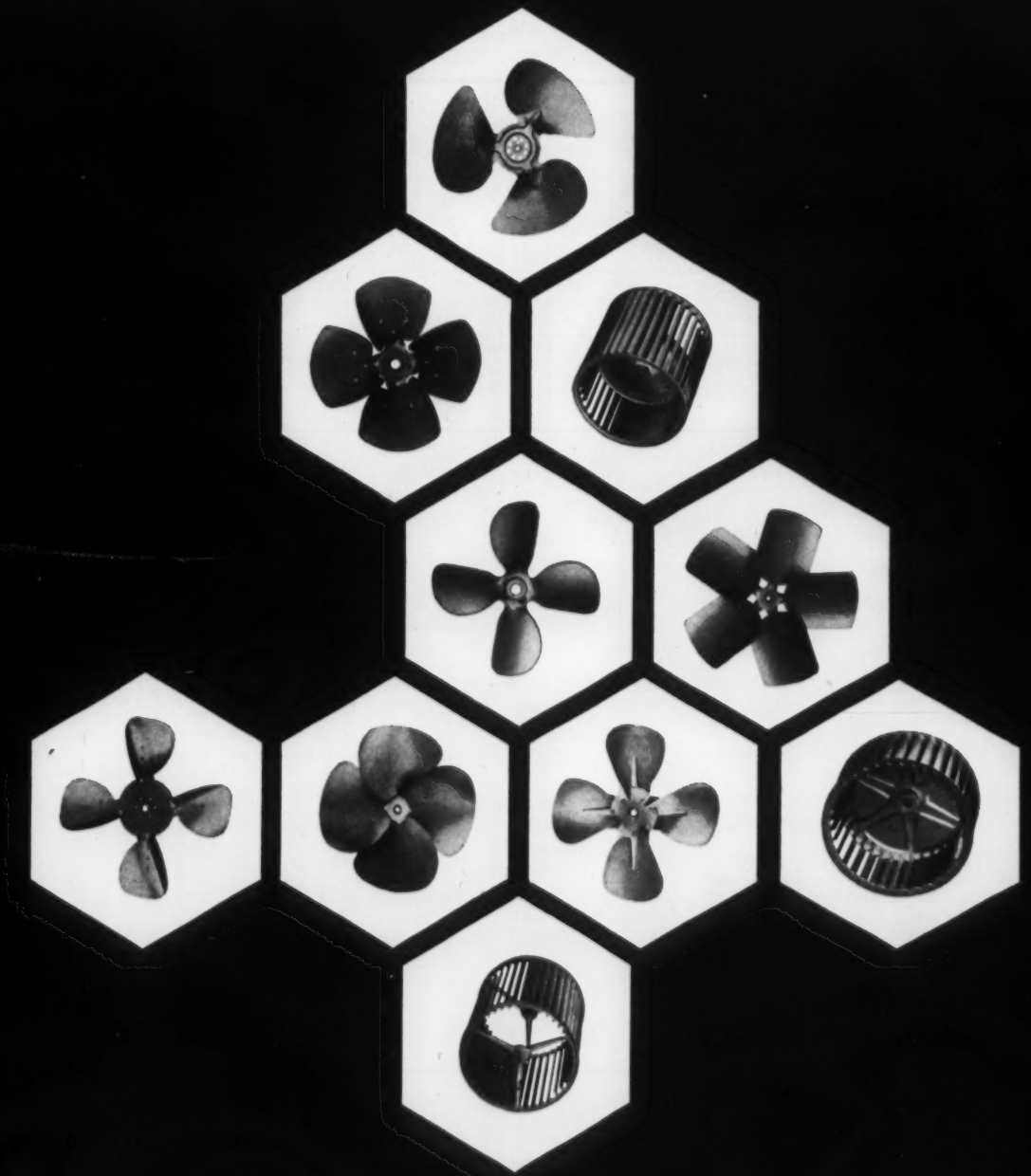




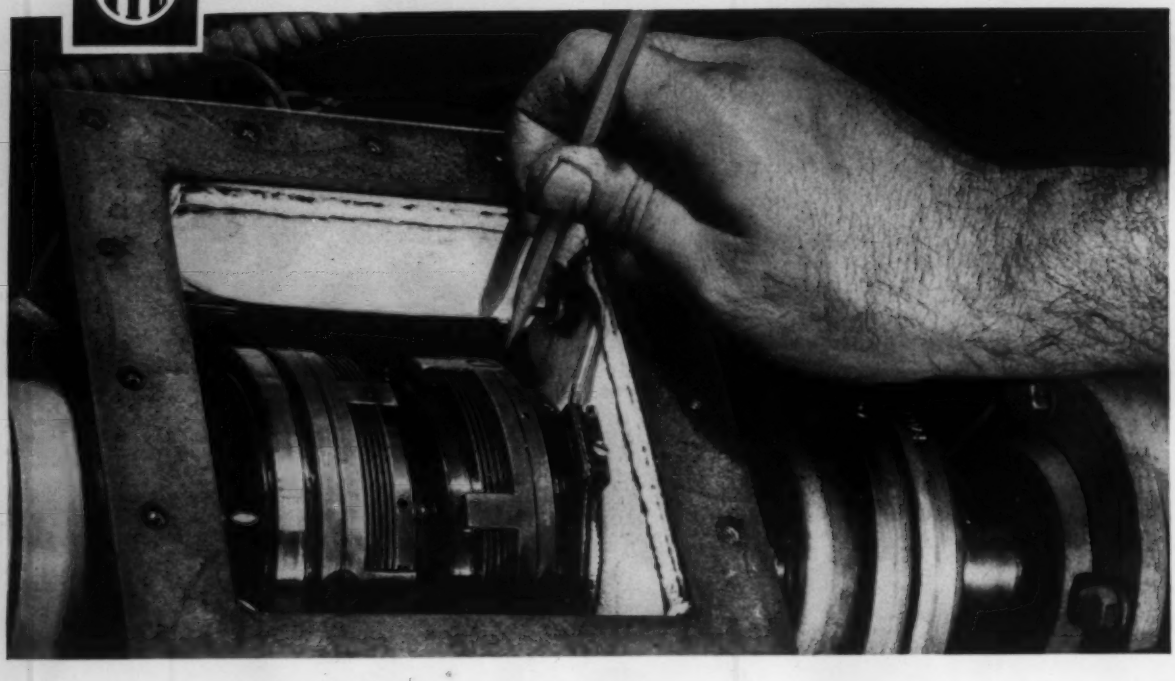
THE TORRINGTON MANUFACTURING COMPANY

TORRINGTON, CONNECTICUT • VAN NUYS, CALIFORNIA • OAKVILLE, ONTARIO

Circle 438 on Page 19



ELECTRO-CLUTCHES



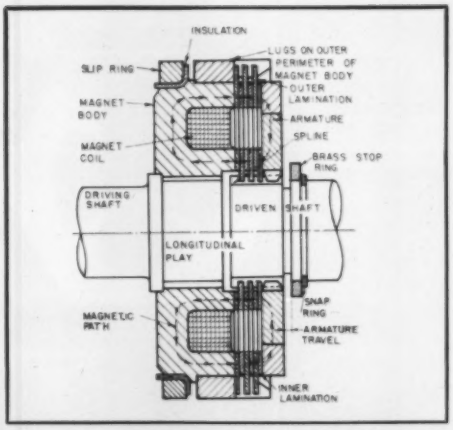
NO ADJUSTING

Get instant speed and feed changes for your machines without need for periodic checking and adjusting of clutches or gradual loss of torque. This is how: insist on genuine I-T-E Electro-Clutches.

No air gap. The patented closed magnetic circuit passing directly through the laminations provides tremendous torque in small space without need for maintaining precision air gaps. So the I-T-E Electro-Clutch goes right on giving uniform, troublefree clutching year in and year out.

More for your money. I-T-E Electro-Clutches are designed to operate in an oil bath. They can go right into your transmission box—often without altering dimensions. All-steel laminations outlast other clutch metals, plastics and friction discs—thus insuring longer clutch life. Safe 24 v operation permits use of telephone type relays, proved for dependability.

Select the exact clutch type you need from a wide range of stock models. For complete information, write I-T-E Circuit Breaker Company, Transformer & Rectifier Division, 19th & Hamilton Sts., Philadelphia 30, Pa.



Principle of operation. Alternate laminations key with perimeter lugs and splined shaft respectively. Rotate freely until magnet coil is energized. Magnetic flux attracts the armature, compressing the laminations with great force, engaging clutch.

I-T-E Electro-Clutches are already in use by these leading companies:

Bullard Fosdick Sundstrand
Giddings & Lewis

I-T-E CIRCUIT BREAKER COMPANY
PHILADELPHIA, PENNSYLVANIA

Circle 439 on Page 19

Here is the KEY to higher VOLUME PROFITS through BETTER ACTUATION!

FREE!

NEW 1958 ENGINEERING DATA BOOK and STANDARD ASSEMBLIES PRICE LIST

from world's largest producer of b/b screws and splines

7 LOW-COST STANDARD SIZES

36-page book is crammed with helpful facts on b/b Screw Basic Operation • Applications • Advantages • Features Characteristics • Technical Data • Standard Assemblies Couplings • Design Data • Engineering Assistance • Service. Make your volume products easier to produce, operate and sell with Saginaw b/b Rolled Thread Screws—they cost no more and are far more efficient than acme screws!

Saqinaw b ROLLED THREAD b Screws

standard assembly

SAGINAW STEERING GEAR DIV., GENERAL MOTORS CORP., SAGINAW, MICH.

SEND FOR YOUR FREE COPY TODAY

Saginaw Steering Gear Division, General Motors Corporation
b/b Screw and Spline Operation, Dept. 4MD,
Saginaw, Michigan

Please send 1958 engineering data book on Saginaw b/b Screws and Splines, and standard assemblies price list, to:

NAME_____

COMPANY_____ TITLE_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

Circle 440 on Page 19

You don't have to be over 21

to install and maintain

a Fenwal temperature indicating controller

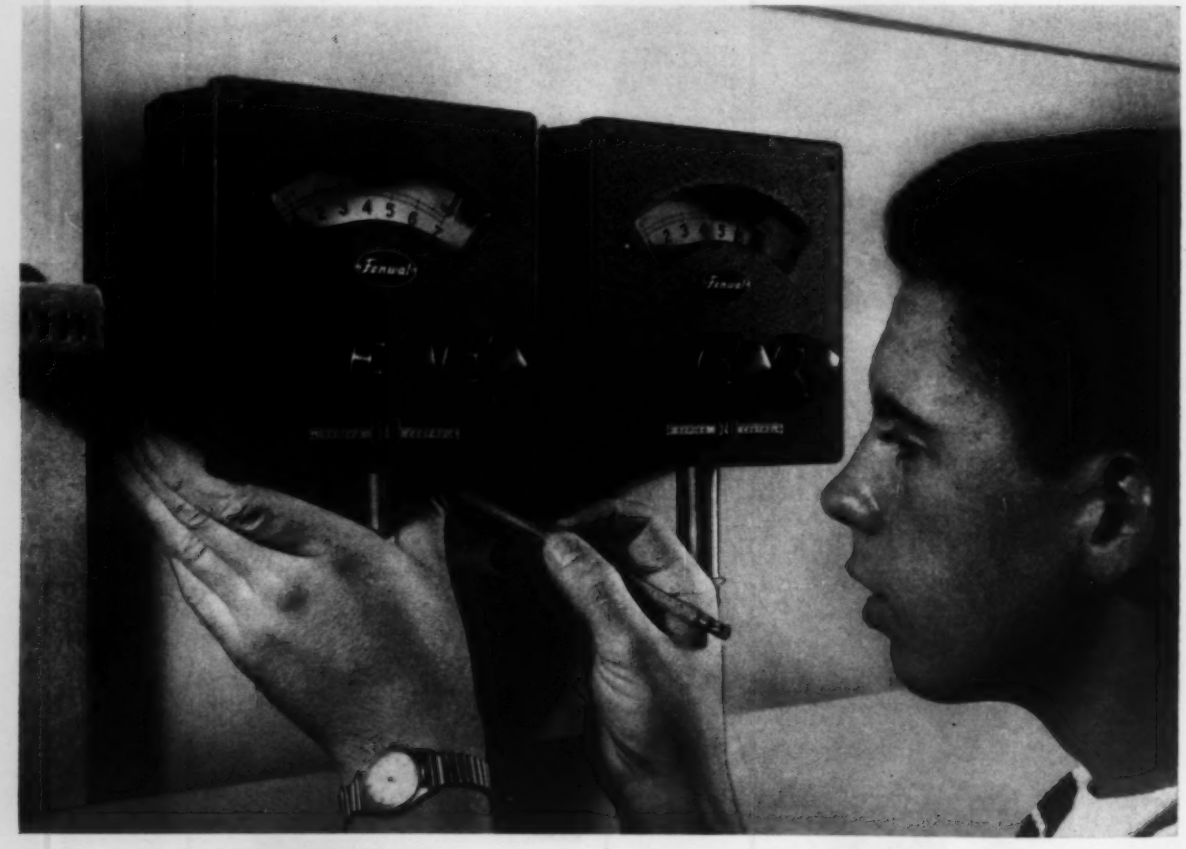
It really is a cinch for an untrained person to install and maintain Fenwal's 541 Temperature Indicator Controller. You don't even have to open the case to adjust it — even its snap switches can be easily replaced without disturbing the internal mechanism. *It's simple!*

In Fenwal's 541 all moving parts are in opposition — wear on one is automatically compensated for and the controller's high accuracy remains unchanged! *It's reliable!*

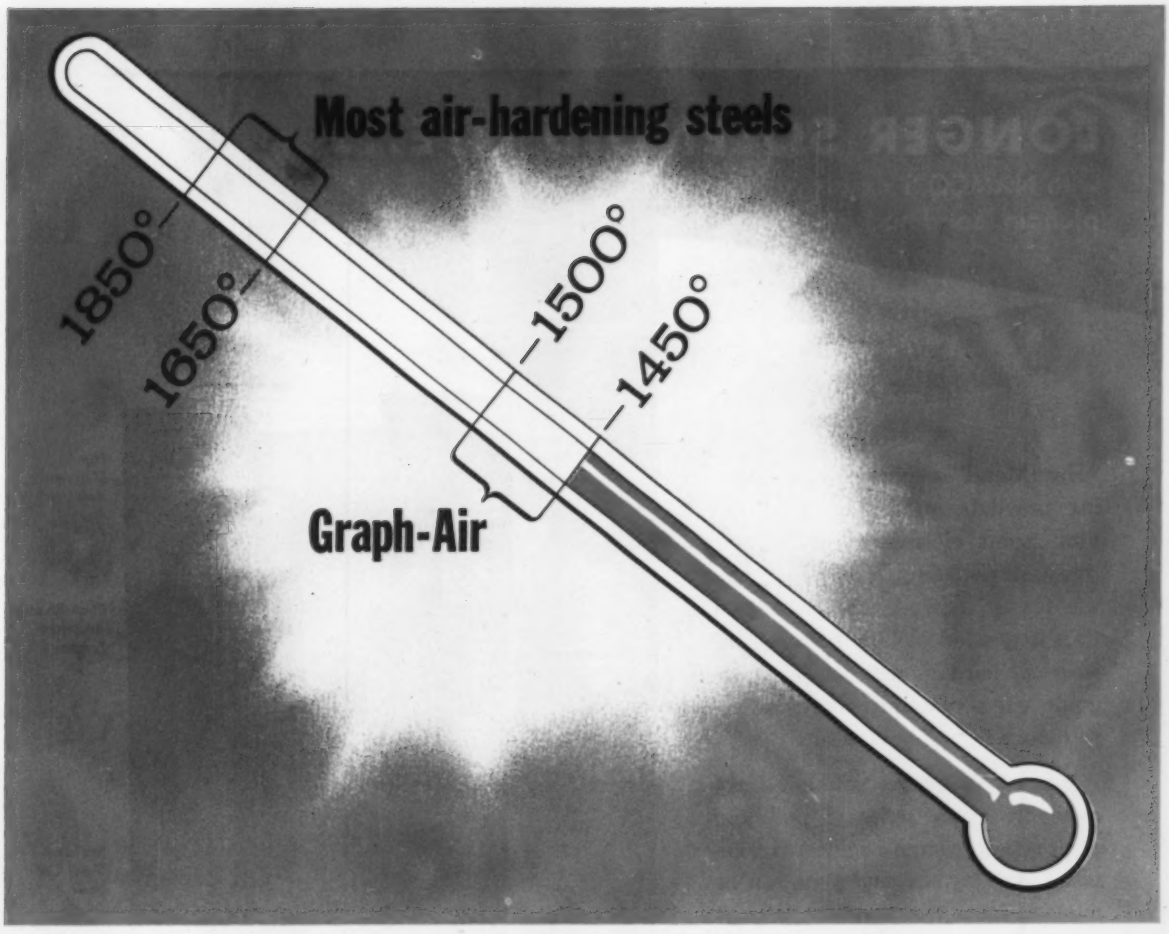
You can take your choice of temperature range, bulb styles, and one or two circuit controls, current ratings — even the color of the housing. There are literally hundreds of adaptations that can be made from stock! So you get a tailor-made, fit-to-order controller at a competitive price! *It's versatile!*

Drop us a line at Fenwal Incorporated, 193 Pleasant Street, Ashland, Mass. and we'll send you our catalog MC-139 or our sales engineer, whichever you want.

This is our dual circuit model (we've got hundreds of others) which has two snap switches, each with a set point indicator, that actuates two circuits at pre-set temperatures. Housing in all Fenwal 541's meet NEMA and JIC specifications.



Fenwal CONTROLS TEMPERATURE . . . PRECISELY



Graph-Air®... *lowest-temperature air-hardening tool steel reduces distortion*

TEMPERATURE as low as 1450°F. is high enough to air-harden Timken Graph-Air® tool steel. That's as much as 400° lower than most other air-hardening tool steels. Because of this, you reduce distortion and simplify heat treat control. And surface scaling and decarburization are minimized.

Graph-Air machines faster, too, because of its graphitic structure. And it's tougher—outwears ordinary tool steels because of the uniform, diamond-hard carbides in its structure.

With Graph-Air you get longer-lasting accuracy because of its built-in stability. Graph-Air is one of the "family" of Timken Company graphitic tool steels, the most stable ever made.

And the uniformity of hardening and reduced distortion you get with Graph-Air make possible more intricate sections. It's ideal for blanking dies and other parts that must stand up under abuse.

For a high quality tool steel that air-hardens at lowest temperature, specify Graph-Air. Available in solid and hollow bar sizes. For further information, please write The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

TIMKEN *Fine Alloy* **STEEL**

TRADE-MARK REG. U. S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

Circle 442 on Page 19

LONGER SOLENOID LIFE...

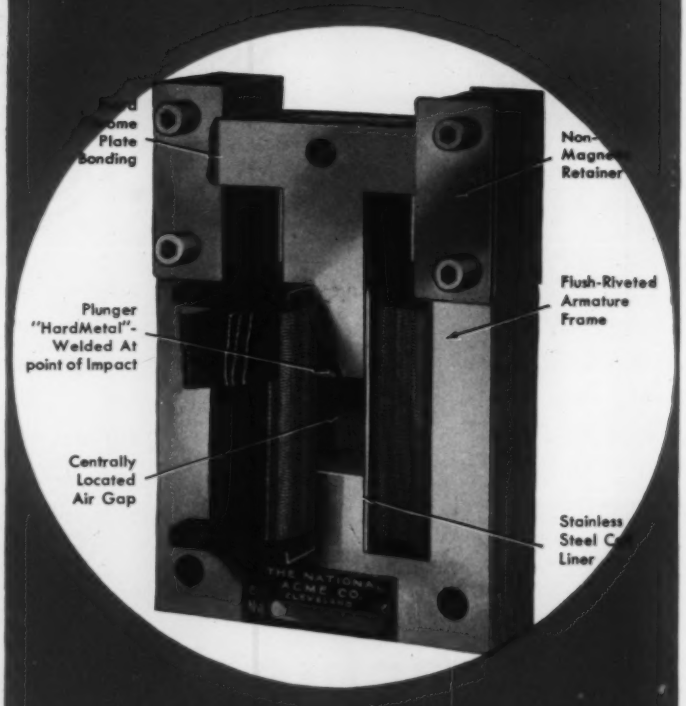
with NAMCO'S exclusive "HARDMETAL"-welded plunger bonding

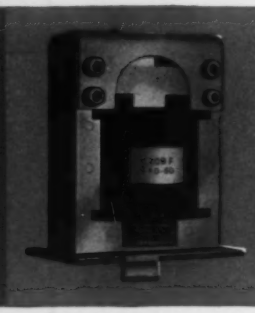
Standard or Custom Models To Fit Your Design

"HardMetal"-welded plunger bonding prevents mushrooming at the vital point of impact—withstands incessant pounding of the plunger on the frame. Long plunger life, and thus long solenoid life, is further insured by hard chrome plating upper guide edges of plunger laminations to reduce friction and wear.

Namco standard solenoids are available in six series of pull and push types; custom-engineered solenoids in every size and type can be made to meet your specifications.

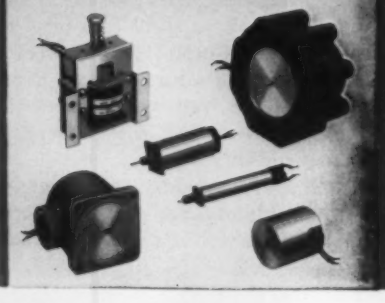
Standard "HardMetal"-Welded Solenoids are furnished push or pull type in sizes with ratings from 2-1/2 to 21 pounds at 1/2" stroke and from 2 to 25 pounds at 1" stroke.





← Saddle stop applied to Series K200 standard Namco push type solenoid.

To meet specific job requirements, solenoids of special shapes and sizes are designed and built through cooperation of our engineers with yours. →



Ask us to send a National Acme Representative to discuss your problems, or if you want more information first—send for BULLETIN EM-52.

ELECTRICAL MANUFACTURING DIVISION

National Acme

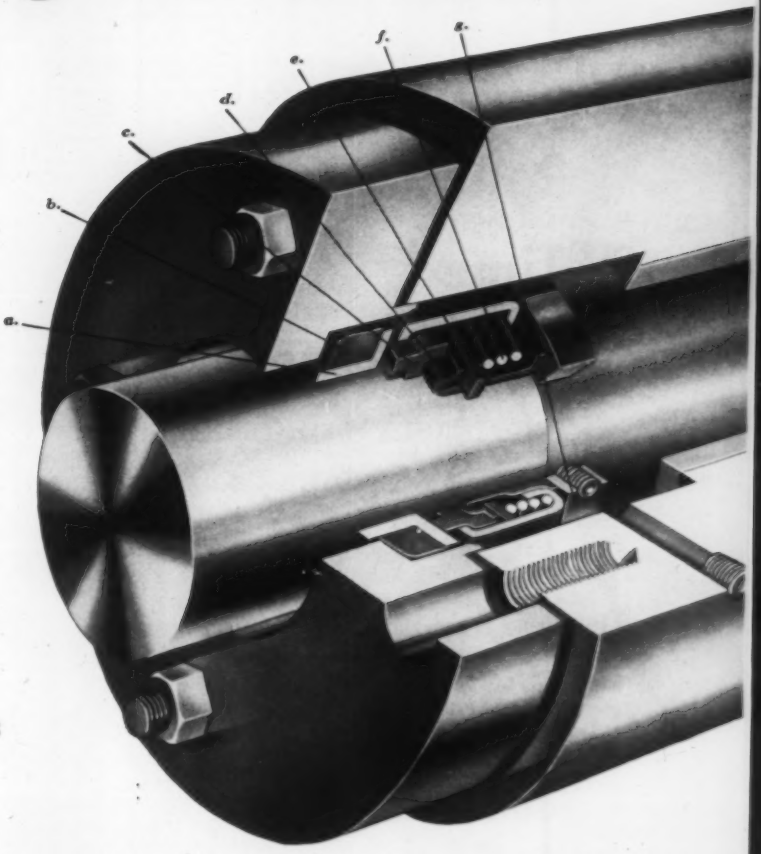
THE NATIONAL ACME COMPANY • 188 EAST 131ST STREET • CLEVELAND 8, OHIO

Circle 443 on Page 19

MORE OF THE GARLOCK **2,000**

No More Stuffing Box Maintenance!

Install Garlock Package Seals on Your Present Pumps



- ELIMINATE LEAKAGE AND SHAFT WEAR
- REDUCE DOWNTIME
- CUT MAINTENANCE COSTS

When leakage and maintenance are serious problems in the operation of your pumps you'll find a perfect answer in Garlock MECHANIPAK* Seals. Installation on new or existing equipment is simple. And, several designs are available to meet a variety of operating conditions: pressures to 150 psi, temperatures to 212° F., and shaft speeds to 2000 feet per minute. Sizes for shafts from 3/8" to 3" diameter for sealing against water, oils, alcohol, mild acids and solvents.

MECHANIPAK Seals are another important part of "the Garlock 2,000"... two thousand different styles of packings, gaskets and seals for every need. It's the only complete line ... that's why you get unbiased recommendations from your Garlock representative. Ask him for complete data on this long-life, maintenance-free MECHANIPAK Seal. Or write for Folder AD-150.

a. ***Stationary Seat*** *of ceramic, Ni Resist, or bronze has precision lapped sealing face for perfect contact with carbon ring.*

b. ***Vibration Ring*** *of Buna-N positions stationary seat in a flexible mounting and acts as static seal.*

c. ***Seal Ring*** *of carbon is also precisely lapped to match sealing face of stationary seat.*

d. ***Roll type Bellows*** *permits free movement of seal ring.*

e. ***Shell,*** *encases entire rotary unit and furnishes mechanical drive for seal ring.*

f. ***Stainless Steel Spring*** *with load precisely calculated to face area of seal.*

g. ***Stop Collar,*** *or shoulder, positions seal to specified operating length.*

THE GARLOCK PACKING COMPANY, Palmyra, N. Y.

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

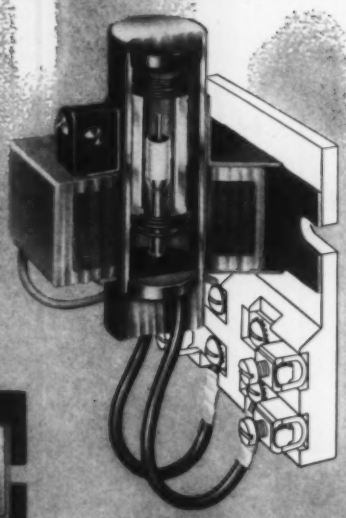
GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints, Fluorocarbon Products

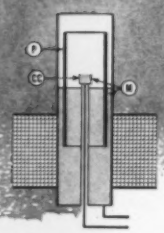
*Registered Trade Mark

Circle 444 on Page 19

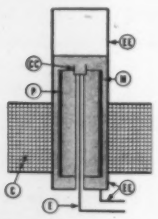
When You Need Reliable Control Of Timed Operations



The "Mighty Midget"
Adlake No. 1140
Plunger-Type Relay
Normally Open • Quick Acting



DE-ENERGIZED
Plunger P is floating in mercury M. External circuit is open because main body of mercury M is below lip of ceramic cup CC.



ENERGIZED
Coil C pulls plunger P down into mercury M. Mercury thus displaced completely covers ceramic cup CC filled with mercury. This establishes mercury-to-mercury contact between electrodes E and EE.

You Need

Adlake

mercury-to-mercury relays

List what you like and don't like in a switch, then see how Adlake meets your need:

- **Immune to vibration**
- **Perfect snap-action—no burning, pitting or sticking**
- **No intrusion of dust, dirt or moisture—hermetically sealed at the factory**
- **Time delay characteristics fixed and non-adjustable**
- **Quiet. Chatterless. Require no maintenance whatever.**

Our engineers will gladly help you with your control problems. No obligation. Just write the original and largest maker of plunger-type relays—THE ADAMS & WESTLAKE COMPANY, 1173 N. Michigan, Elkhart, Ind. • New York • Chicago

Circle 445 on Page 19

HAYNES Alloys solve *tough* wear and corrosion problems

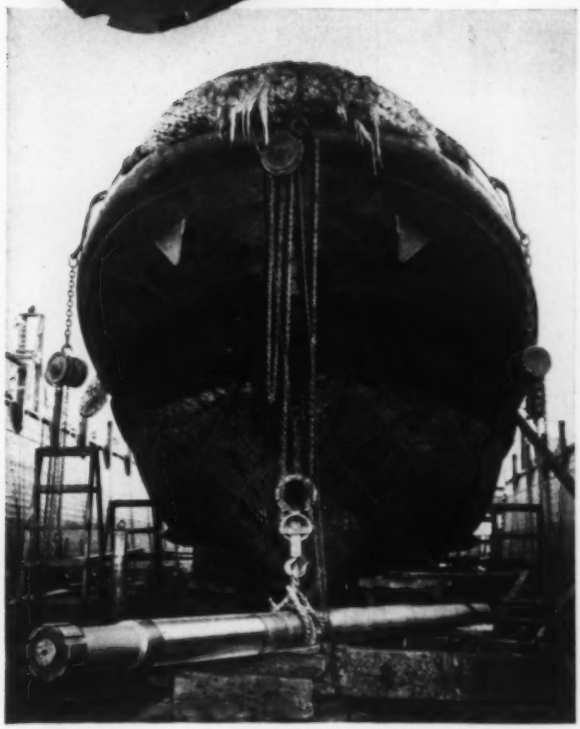
New Method

Eliminates maintenance on bearing area of shafts

After 17 months of grueling service in the sandy salt water of New York's harbor and surrounding waters, a tail shaft sleeved with a HAYNES wrought alloy at the outer bearing area showed only 0.015 in. wear. A bronze sleeve used in this same service wore over ¼ in. in 15 months.

This remarkable improvement in wear resistance was accomplished quickly and economically by the use of half sleeves made of HAYNES STELLITE alloy. Three sets of the half sleeves protected the bearing area of the shaft.

For more information on the many industrial applications for HAYNES STELLITE alloy half sleeves and bushings, ask for a copy of our free booklet. Write HAYNES STELLITE COMPANY, Division of Union Carbide Corporation, General Offices and Works, Kokomo, Indiana.



No Wear or Corrosion After 17 Months. Tug's tail shaft is removed for inspection of HAYNES STELLITE alloy sleeves at the outboard bearing area. The sleeved surface still has a mirror-like finish.

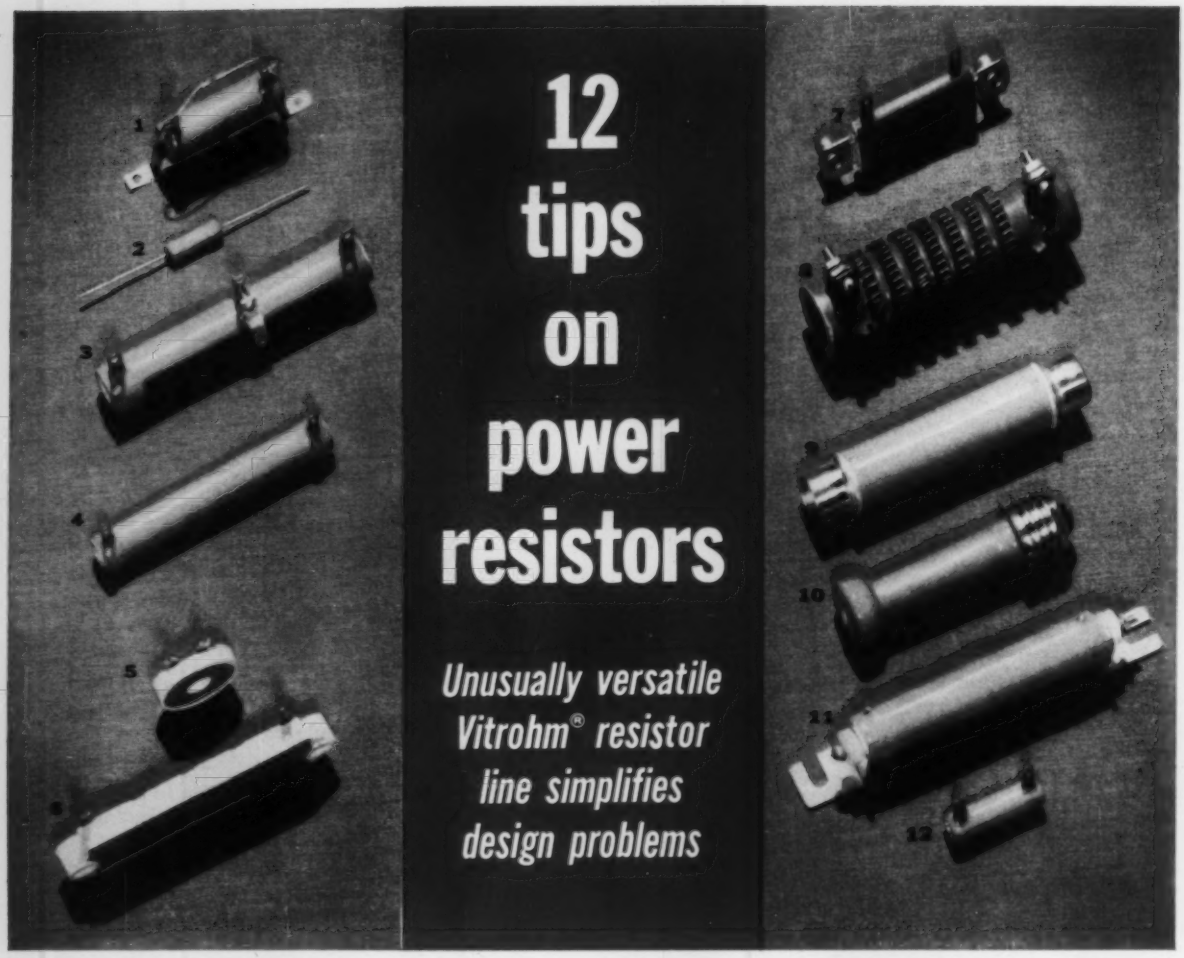
HAYNES
ALLOYS

HAYNES STELLITE COMPANY
Division of Union Carbide Corporation
Kokomo, Indiana

UNION CARBIDE

"Haynes," "Haynes Stellite" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

Circle 446 on Page 19



Did you know that high reliability Vitrohm Resistors can take on almost every shape the designer needs? More than 11 styles fit almost every design requirement. All have the same outstanding Ward Leonard quality—quality that protects *your* reputation as an equipment designer. For example:

1 FIXED Vitrohm tubulars come in 5-to-200 watt sizes. **2** AXIOHM, standard in 3, 5, or 10 watts, with axial leads is ideal for compact electronic gear. **3** ADJUSTOHMS make it easy to get the right voltage, bleeder or bias current.

4 NON-INDUCTIVE Vitrohm tubulars, up to 160 watts in stock sizes. Famous flatted sides and 'Ayrton-Perry' winding keeps down inductance and capacitance. **5** DISC-OHMS, at 24 watts, feature extra compact mounting and **6** PLAQOHMS, sizes to 150 watts, are also non-inductive. **7** STRIPOHMS, from 20 to 75 watts, are another way to save space—an easy, compact way to stack mount resistors. **8** RIBFLEX resistors (made to order) can dissipate up to 550 watts and take terrific momentary overloads. Resistances from 0.04 to 66 ohms.

9 FERRULE TERMINAL resistors (made to order) feature fuse-clip-type mounting. **10** SCREW BASE resistors (also made to order) are suited to equipment requiring ready change of resistance values. **11** BRACKET TERMINAL resistors have leads silver-brazed to mounting brackets. Mounting the resistor completes electrical circuit.

12 MIL-R-26C Vitrohm Resistors available in all styles—all sizes—all characteristics and all resistance values listed in the specification.

Designing with power resistors is easy with the 64-page Ward Leonard Catalog 15. It's full of data on these resistors and more. Write for your copy today. Ward Leonard Electric Co., 58 South Street, Mount Vernon, N. Y. (In Canada: Ward Leonard of Canada, Ltd., Toronto.)

8.1

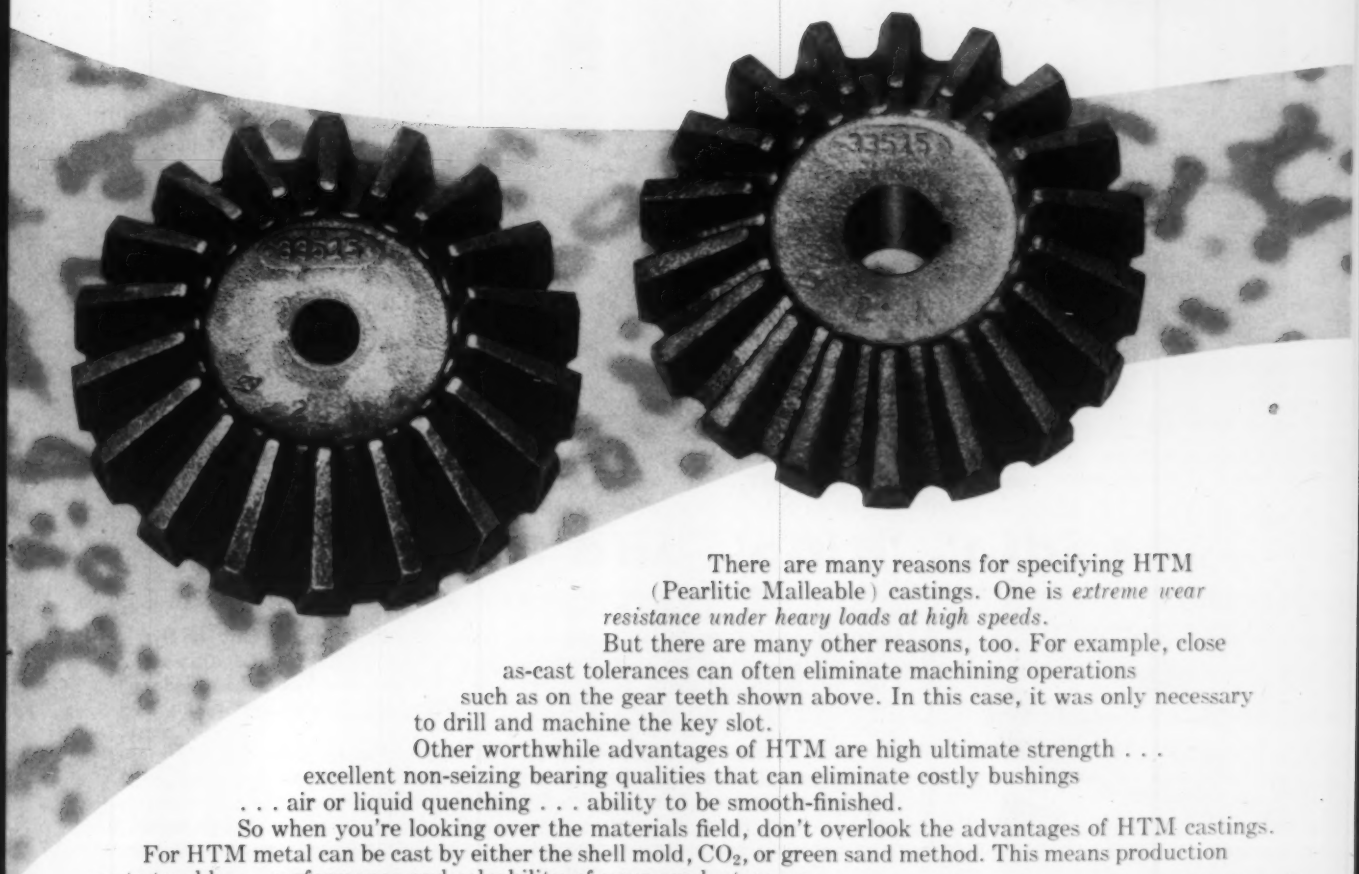
LIVE BETTER...*Electrically*

is your problem

wear resistance?

NATIONAL HTM CASTINGS

are the answer



There are many reasons for specifying HTM (Pearlitic Malleable) castings. One is *extreme wear resistance under heavy loads at high speeds.*

But there are many other reasons, too. For example, close as-cast tolerances can often eliminate machining operations such as on the gear teeth shown above. In this case, it was only necessary to drill and machine the key slot.

Other worthwhile advantages of HTM are high ultimate strength . . . excellent non-seizing bearing qualities that can eliminate costly bushings . . . air or liquid quenching . . . ability to be smooth-finished.

So when you're looking over the materials field, don't overlook the advantages of HTM castings. For HTM metal can be cast by either the shell mold, CO_2, or green sand method. This means production costs tumble . . . performance and saleability of your product go up.

AA-6928

IMPORTANT PHYSICAL PROPERTIES	
Brinell	163 to 302*
Yield, psi	48,000 to 85,000*
Ultimate, psi	70,000 to 110,000*
Elongation, %	7 to 2*

*Depending upon grade

NATIONAL MALLEABLE and STEEL CASTINGS COMPANY

Established 1868 *Cleveland 6, Ohio*

The nation's largest independent producer of malleable and pearlitic malleable

Circle 448 on Page 19

Readin', 'Ritin', and Reliability

Synthane plastic laminated bushings and breaker arms for automotive ignition.

Dependable operation of a school bus, a truck, or your own car involves the functioning of many parts. One breakdown can wipe out the memory of ten thousand trouble-free miles.

Some of these parts are made of laminated plastics. They're usually unseen, unsung, small in size yet efficiently performing their job.

Their cost is relatively insignificant when compared with the cost of equipment in which they work, but it should be sufficient to insure dependability.

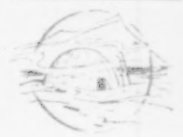
Actually, what you pay for Synthane laminated plastics is little or no more than you'd pay for any other plastic laminate. But the Synthane price includes top quality materials, product control, excellent facilities and workmanship, an assurance of continuous supply, and a long reputation for fair dealing.

If you are interested in a reliable source of laminated plastics—sheets, rods, tubes, or completely fabricated parts, write for an interesting catalog or call our representative nearest you.

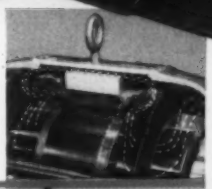
SYNTHANE

SYNTHANE CORPORATION, 5 RIVER RD., OAKS, PA.

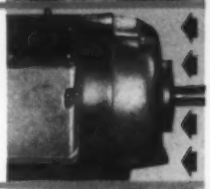
NEW R&M Re-Rated Series 254U All-Weather Motors



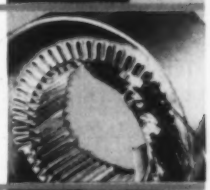
"straight through" dual-sweep ventilation eliminates "hot spots"



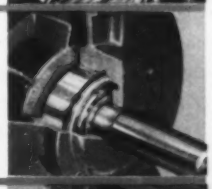
full height end head protection



Mylar insulation increases motor life*



bearings easily inspected by removing cover plate



permanently numbered leads simplify installation and maintenance

*DuPont registered trademark.

Premium Performance

. . . at standard motor prices

R&M Series 254U Motors help pay their own way from the minute you flip the switch! They stoutly resist any hostile environment — moisture, dirt, heat, acid or alkaline fumes — and so live longer. They have push-pull ventilation that won't let dirt settle and keeps motor internally cool — and so perform with full, brisk efficiency. Their oversize bearings are quick and easy to inspect and relubricate — so your maintenance costs dwindle.

This long, trouble-free, vigorous motor life is what R&M means by "Premium Performance" — an extra reward in service and savings every R&M motor offers. These and other big, money-saving advantages shown at left cost no more . . . R&M motors carry standard motor prices!

Write today for R&M Bulletin 520-MD!

Robbins & Myers build motors from 1/200 to 200 horsepower

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO / BRANTFORD, ONTARIO

Circle 450 on Page 19

Wear Resistance is a common problem for designers, even when they're using a durable material like steel. Of course, it is well known that you can increase the abrasion resistance of a given steel when you improve its hardness (and thus, its strength). But when you harden and strengthen a steel so that it will resist wear, you usually run into some complications.

For instance, when we vary the wear resistance of steel, we also vary its *other* properties, and this causes problems for the designer or his metallurgical adviser. Examples: hardness and strength can be developed in various ways—increase the carbon content, add alloying elements, cold work, heat treat. These methods vary in cost, and each has a different effect on hardness, strength, toughness, corrosion resistance, formability and weldability.

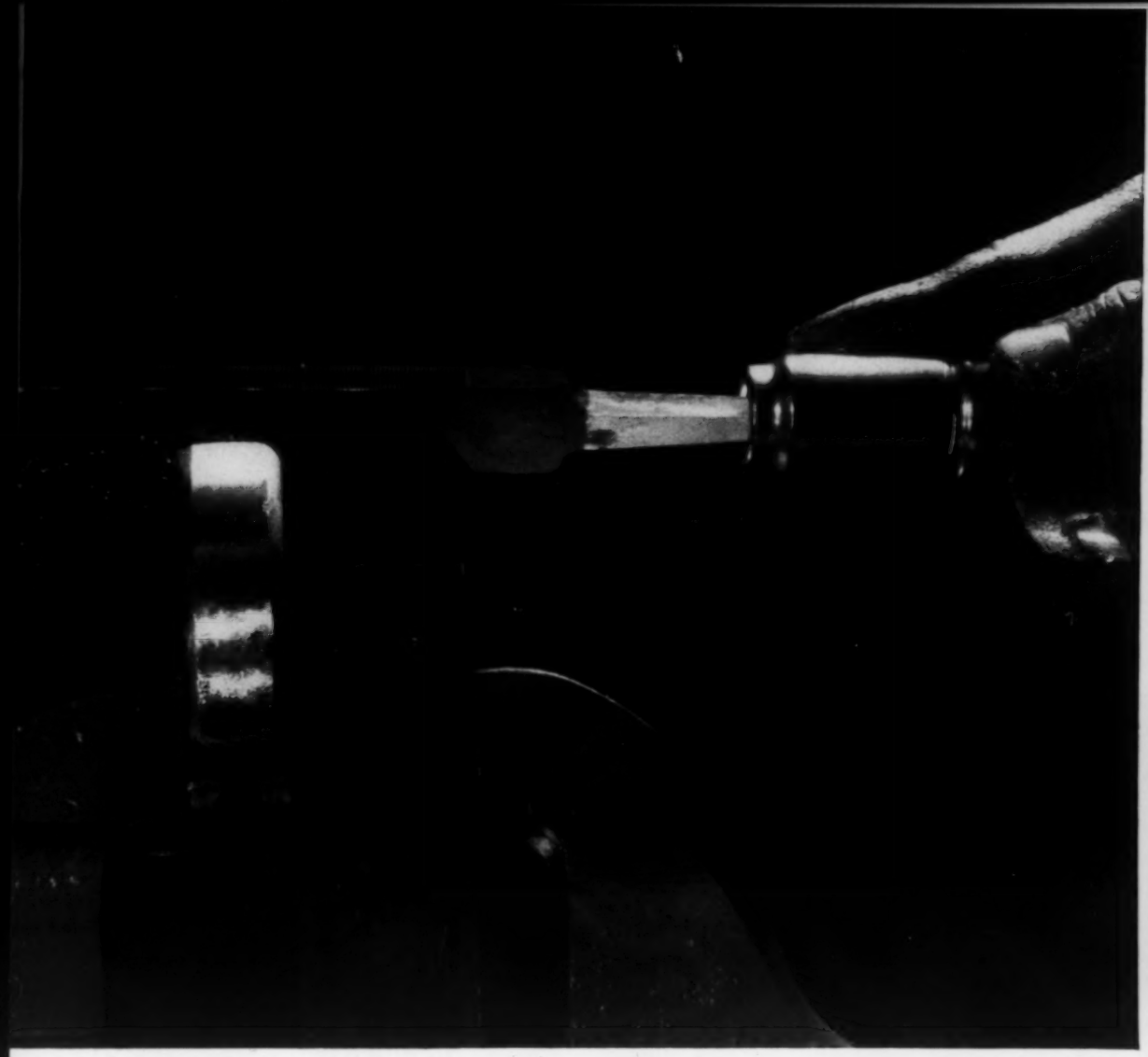
There is one steel with the best combination of properties for every design application, and you're almost sure to find it in the vast range of USS Design Steels—whether Carbon, High Strength, Alloy or Stainless Steel. Here is the widest range of steels available, offered by a company that has produced well over a *billion* tons of steel.

Of course, over-design must be avoided as rigorously as under-design, and designers must always walk the prickly path between poor product performance on one hand and high costs on the other. Somewhere among the many USS Design Steels there is the one best steel for the job. The final selection can best be made with the help of a skilled metallurgist—either on your staff or ours.

USS **United States Steel**

Circle 451 on Page 19

STEELS FOR DESIGN



Lower Left—Problem: Blades on this earth dammer wore out after 300 acres. Solution: Blades are now made from USS MAN-TEN Steel, one of several USS HIGH STRENGTH STEELS. Benefit: Blades now last over 1,000 acres for Gunning Mfg. Co., Lansford, N. D.

Lower Middle—Problem. The new "Snow Hawg" rotary snow plow chews into ice, rock and frozen earth and throws it up to 300 feet. A weldable, very strong steel was needed to withstand the punishment. Solution: Vital parts are made from USS "T-1" Constructional Alloy Steel. It can be field-welded, and remains strong and tough down to minus 50°F. Benefit: Outstanding performance, and chute liners of the "Snow Hawg" last two to three times longer.

Lower Right—Problem: Chutes in a coal processing plant wore out prematurely due to abrasive action of coal and corrosion from acid water. Solution: Chutes made from USS Stainless Steel were installed. Benefit: New chutes outlast old ones seven to one. Atkins Coal Company, Frackville, Pa., estimates that a $900 investment in Stainless Steel chutes saved $30,000.

USS, MAN-TEN and "T-1" are registered trademarks of United States Steel

T-J spacemaker cylinder

Quality Engineered

to give quality results

with Extras . . . at No Extra Cost!

You get more—much more—when you specify and use any of T-J's complete line of Spacemaker cylinders. The Spacemaker is engineered to give you better, more accurate, and longer service—offers, exclusively, many extras . . . that are STANDARD, AT NO EXTRA COST!

Designed to eliminate tie-rods, providing greater strength . . . saves space . . . reduces manhours and costs in all push-pull-lift operations. OFF SHELF DELIVERY in a wide range of styles and capacities, with 64,000 combinations. Write for catalog SM 56-2 with complete engineering details. The Tomkins-Johnson Co., Jackson, Mich.

METAL PISTON ROD SCRAPER . . . Standard at No Extra Cost!

NEW "SUPER" CUSHION FOR AIR . . . Standard at No Extra Cost!

CHROME PLATED CYLINDER BORES AND PISTON RODS . . . Standard at No Extra Cost!

ONE PIECE PISTON . . . Standard at No Extra Cost!

NEW "SELF-ALIGNING" MASTER CUSHION FOR HYDRAULIC USE . . . Standard at No Extra Cost!

NO TIE-RODS TO STRETCH . . . Standard at No Extra Cost!

STREAMLINED DESIGN . . . Oil Pressure to 750 P.S.I.—air to 200 P.S.I. Standard at No Extra Cost!

FORGED SOLID STEEL HEADS . . . Standard at No Extra Cost!

T-J TOMKINS-JOHNSON
RIVETERS, AIR AND HYDRAULIC CYLINDERS, CUTTERS, CLINCHERS

SEE US AT BOOTH 1423
A. S. T. E. SHOW

Circle 452 on Page 19

Machining spur gears made from Bethlehem forged-and-rolled blanks.

When the Blank is Sound, Machining Costs Go Down

You probably know a machinist whose specialty is gears. Some day ask him what a sound blank means in terms of machining speed. Ask him how a sound blank reduces costs.

Directly or indirectly, his answers will tell you why Bethlehem gear blanks are so widely specified. Wherever these sturdy Bethlehem products are used, their advantages are instantly apparent. Made in a two-way mill that both forges and rolls the steel, they are highly uniform and very strong throughout. Internal structure is excellent. There are no hidden pitfalls beneath the surface to snag the cutting tool, delay the work, or cause rejects. These circular blanks can be turned, bored, faced, and hobbed with complete assurance of a good finished job in every respect.

You can obtain Bethlehem forged-and-rolled blanks in sizes from 10 to 46 in. OD, heat-treated or untreated. They are available in a wide range of sections. Use them not only for gears, but for crane and sheave wheels, flywheels, turbine rotors, brake and clutch drums, pipe flanges, etc. Many details are covered in Booklet 216, a copy of which will be mailed at your request.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

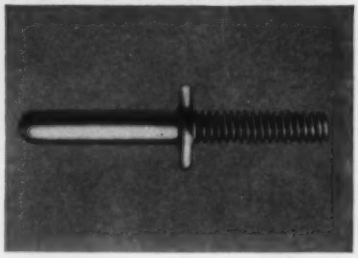
BETHLEHEM STEEL

BETHLEHEM STEEL

Circle 453 on Page 19

National SPECIAL PRODUCTS SERVICE

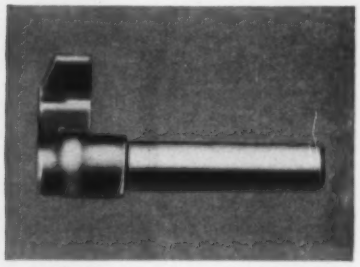
Precision parts with closely held tolerances and excellent surface finish, like this, can also be cold headed more economically and quickly.



Small parts like this can be produced, by cold heading, in huge hourly volume and at low unit cost.

Get strength at low cost with

COLD HEADED SPECIALS!



Intricate formations, like this, difficult or too costly by other methods, become routine production in the cold heading process.

You can make remarkable savings and get better parts in many cases by letting us duplicate and improve on parts you previously have had machined, cast or forged. It's possible with National cold heading!

What's more, we can quickly tell you whether cold heading would be an advantage for new designs.

Here's how National cold heading reduces unit costs . . . gives you better parts!

You save on production costs, because cold heading is fast . . . production rates of 50 to 300 pieces per minute are common. You don't pay for waste. Scrap loss in cold heading is negligible. You save on cost of extra operations, because cold heading eliminates them entirely or reduces their number. And most secondary operations, when required, can be performed automatically in mass production.

Cold heading assures strong, sound parts with good finish and excellent resistance to fatigue, shear and impact!

You're sure of strong parts because cold working *increases* the strength of steels and nonferrous metals. Subsequent heat-treatment or hardening can produce practically any degree of physical properties you desire.

You're sure of sound, clean parts because any defects, such as seams and inclusions, will open up in cold working . . . resulting in *automatic rejection.*

You're sure of superior fatigue, shear and impact resistance because cold heading produces continuous, unbroken flow lines in the grain of the metal . . . impossible to obtain by any other method.

You're sure of good surface finish, with a maximum of 50 micro-inch on cold headed surfaces. Cold heading won't cut or break the specially prepared, smooth, compressed and toughened surface of the rod.

National's cold heading specialists have many years of design and production experience. Combined with National's tremendous facilities for cold heading and secondary operations, this assures you of outstanding work and help in design and production of your parts.

Write for National's booklet, *Special Products.* To learn more about what National cold heading can do for you, send us your specifications or call in your nearest National representative.

THE NATIONAL SCREW & MFG. CO. • CLEVELAND 4, OHIO

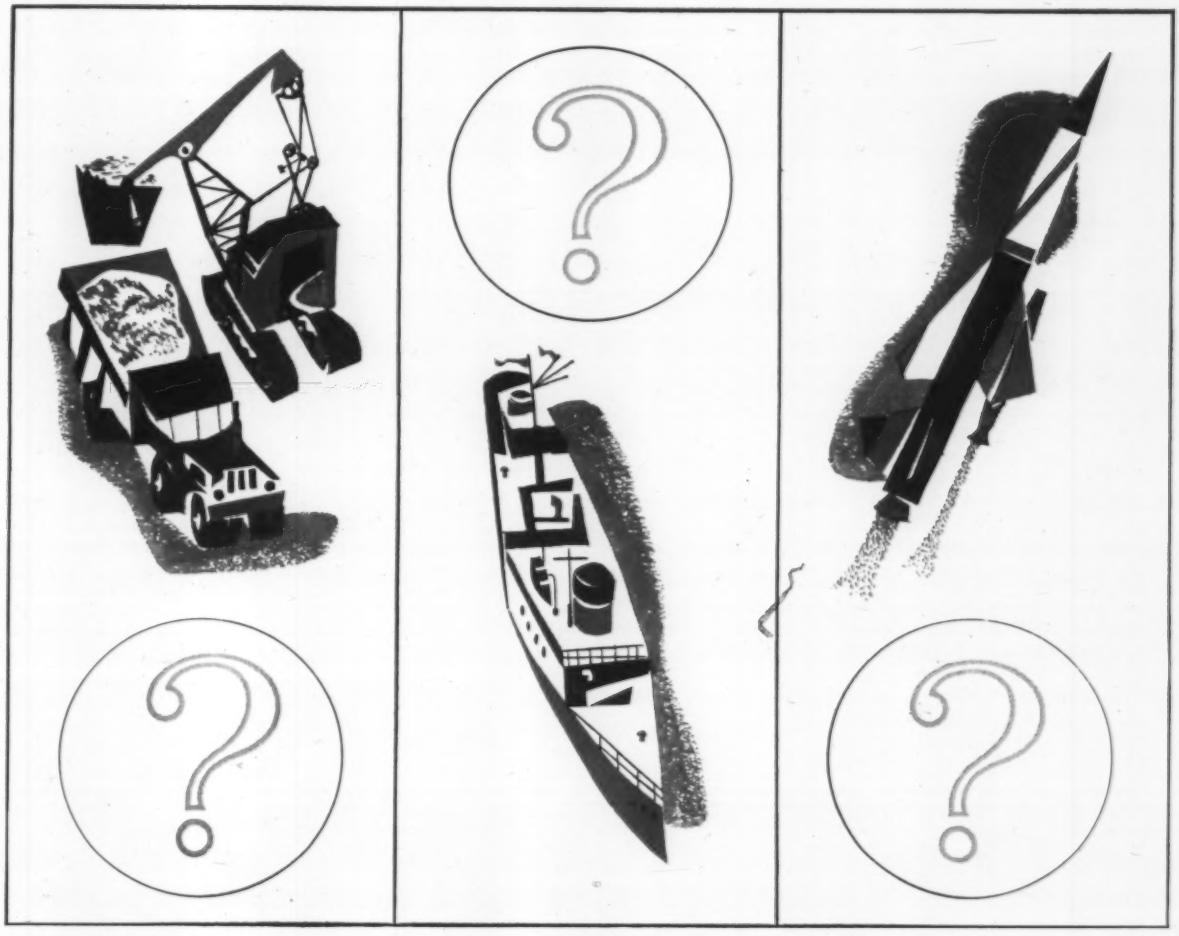
***Pacific Coast:* National Screw & Mfg. Co. of Cal. • 3423 South Garfield Ave., Los Angeles 22, Cal.**

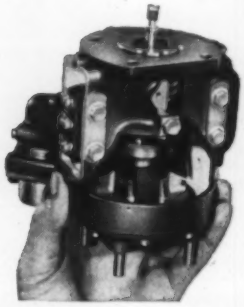
National PRODUCTS

Fasteners **Hodell Chains** **Chester Hoists**

Circle 454 on Page 19

are you looking for switches controlled by speed





AC-Milwaukee now produces a speed sensing switch so sensitive that it operates, and continues to operate, within ½ of 1% of turbine speeds ranging from 500 to 4600 rpm. If you need to control from one to four engine functions in relation to turbine speeds, AC has the answer. This speed sensing switch has proved itself in thousands of operational hours on military jet aircraft . . . controlling ignition systems and afterburners in flight.

The AC Speed Sensing Control weighs about four pounds and is compact enough to be mounted almost anywhere. It holds calibration even when subjected to high engine vibration . . . can operate without servicing for periods up to those recommended for jet engine overhaul.

For help in solving any problem related to automatic control of electrical switching operations, call AC-Milwaukee.

If you are an engineer with a mechanical, electronic or electrical background, and would like to work with AC's Milwaukee group, write Mr. Cecil Sundeen, Supervisor of Technical Employment, Dept. K, 1925 C. Kenilworth, Milwaukee 1, Wisconsin.

AC SPARK PLUG ⚛ THE ELECTRONICS DIVISION OF GENERAL MOTORS

Inertial Guidance Systems • Afterburner Fuel Controls • Bombing Navigational Computers • Emergency Fuel Controls
Gun-Bomb-Rocket Sights • Gyro-Accelerometers • Gyroscopes • Speed Sensitive Switches • Speed Sensors • Torquemeters

How to increase product reliability by eliminating the loose fastener problem

Use UNBRAKO self-locking socket screws to keep your assemblies tight

With the Missile Age has come the realization that as mechanisms become more complex and automatic, every part must have a high degree of reliability, regardless of size or function, no matter how insignificant it may seem.

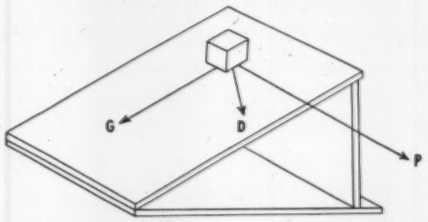
Most product mechanical failures occur at or around joints—the points of high stress concentrations. Threaded fasteners are widely employed to secure joints because they usually must be designed for disassembly as well as assembly. Far too frequently, however, they vibrate loose, acting more like "threaded looseners," and causing equipment malfunction, breakdowns and customer complaints. In some instances—ordnance or aircraft, for example—the consequences can be disastrous.

UNBRAKO socket screws with the Nylok* self-locking feature offer you a simple, practical solution to this problem. An UNBRAKO with Nylok is a single, self-locking unit requiring no auxiliary locking devices, no extra time or labor to install. The tough, resilient nylon pellet forces mating threads tightly together, locking the screw securely, seated or not, wherever wrenching stops. It will not work loose, despite severe vibration. Furthermore, a self-locking UNBRAKO can be used repeatedly. In contrast, lockwashers sometimes snap or lose their spring if frequently tightened; and a cotter pin cannot safely be used more than once.

Off the shelf, a self-locking UNBRAKO may cost slightly more than an ordinary fastener. But f.o.b. your product, it usually costs less . . . assembly time, labor and reliability factor considered. See your authorized SPS distributor for complete details. He carries a full line of UNBRAKO self-locking products. Or write us for literature and samples. Unbrako Socket Screw Division, STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

*T.M. Reg. U.S. Pat. Off., The Nylok Corporation

HOW A SCREW WORKS LOOSE



The reason why a screw works loose under vibration is best explained by the analogy of a free block on an inclined plane, illustrated above. The slope is such that friction keeps the block from sliding (G). But if an external force starts to move the block sideways (P), friction can be reduced to the point where the block begins to slide down at the same time (D). A similar action takes place with screw threads. Tightening the screw forces the thread "uphill" against the thread of the nut or tapped hole. This sets up tension in the screw, creating enough friction between mating threads to hold it tight—under some conditions. Often, however, vibration causes marked variations in screw tension, resulting in motion between mating threads to the point where they begin to slip past one another or "run downhill." The result: a threaded loosener.

LOCKED! The tough, resilient nylon pellet—permanently installed—keys itself into mating threads, forcing them tightly together and locking the screw securely. Self-locking UNBRAKOS will not work loose, despite severe vibration.

hiR High Reliability factor

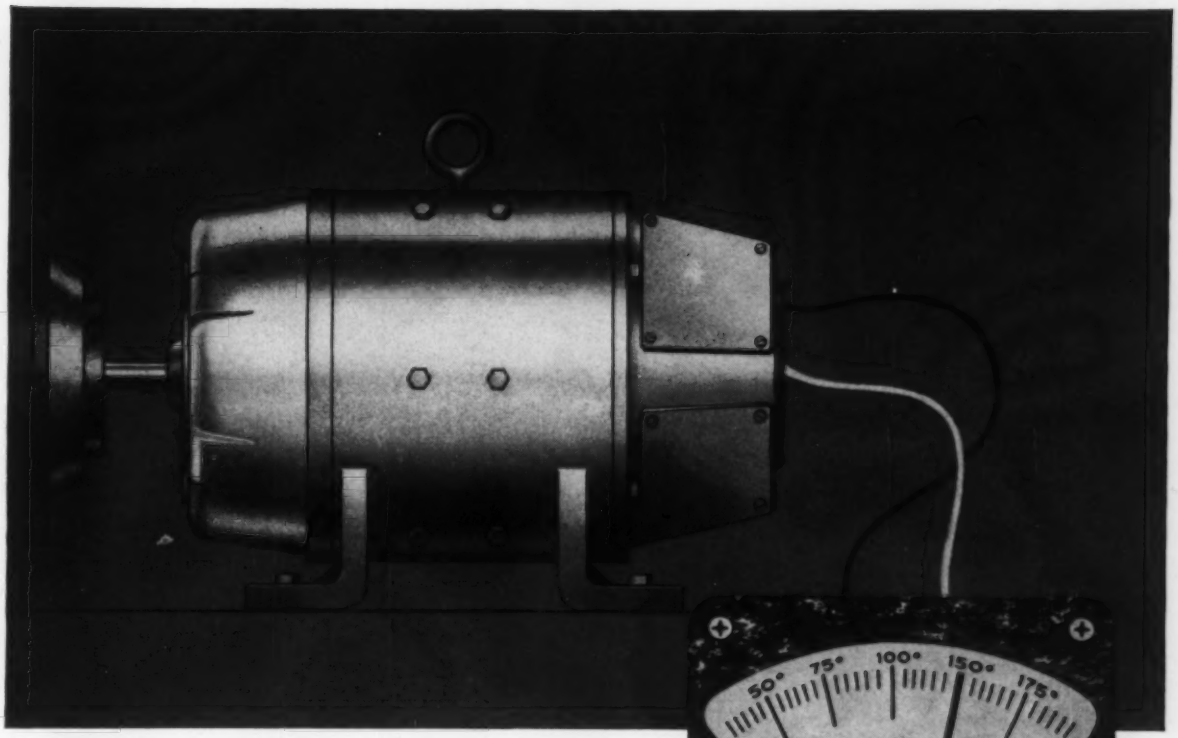
At SPS we apply a dynamic standard of quality—continually refined—so that our fasteners will always have the high reliability factor required by today's faster speeds, higher temperatures, and greater dynamic forces. By using SPS fasteners in your assemblies, you increase overall reliability—the certainty of predictable performance under actual service conditions.

For more information on the science of reliability—the newest branch of product engineering—write for a copy of the SPS booklet "Concerning High Reliability"—just published.

We also manufacture precision titanium fasteners / write for free booklet

SPS **Jenkintown • Pennsylvania**

Standard Pressed Steel Co. • The Cleveland Cap Screw Co. • Columbia Steel Equipment Co. • National Machine Products Co. • Nutt-Shel Co. • SPS Western • Standco Canada Ltd. • Unbrako Socket Screw Co., Ltd.



You Can Boost Equipment Operating Temperatures Up to 150°C with Westinghouse Insulating Varnish B-185!

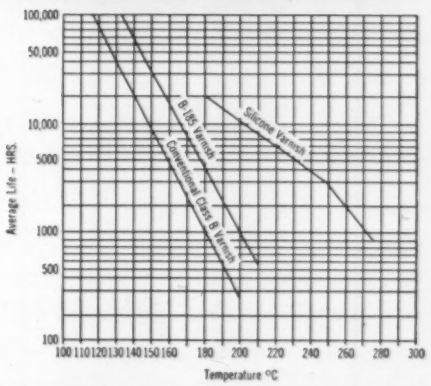
Here's the answer to many an insulating problem—new Westinghouse insulating varnish "B-185" permits you to boost equipment operating temperatures up to 150° intermittently, 140° continuously!

"B-185" is a clear, thermosetting, all-purpose dipping varnish developed specifically for treating rotors, stators, control coils and similar electrical windings. It has good flexibility to meet the requirements of all such applications.

Sound good? It *is* good! Because "B-185" is another *Leadership Line* product developed by Westinghouse research, field-tested in millions of applications to give you the finest insulation products money can buy. Virtually all Leadership Line materials *far exceed* rather than merely "meet" their particular class standards of performance.

Why not check the facts on "B-185" as well as other Westinghouse *Leadership Line* insulating varnishes, enamels and varnished insulations? Send today for your free copy of the *Leadership Line Catalog* giving you complete technical and application data.

J-06658



Curve illustrates heat life comparison of B-185 with conventional Class "B" and Silicone varnish, using Varnished Glass Cloth Test Method. Samples of varnished glass cloth are aged at various temperatures until breakdown occurs at one-half the original dielectric strength.

Westinghouse Electric Corporation EM-10-57
Benolite Division, Manor, Pa.
Please send me your Leadership Line Catalog on Westinghouse flexible insulation, tapes, resins and varnishes.

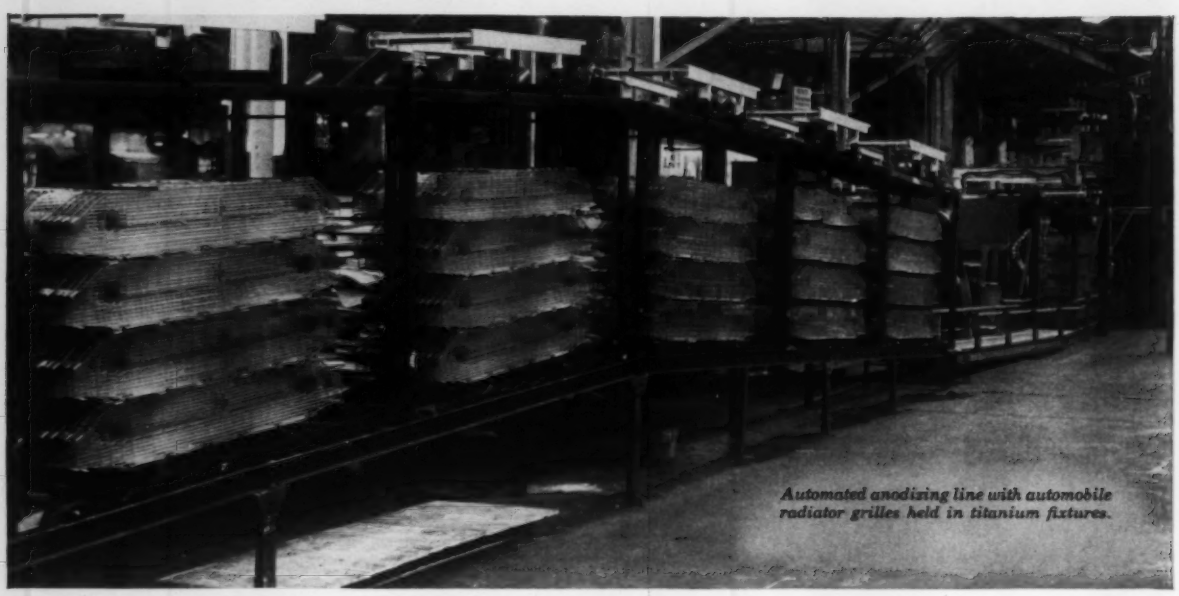
Name_____
Title_____
Address_____
Company_____
City_____ State_____

YOU CAN BE SURE... IF IT'S

Westinghouse

Circle 456 on Page 19

Progress with **TITANIUM**



Automated anodizing line with automobile radiator grilles held in titanium fixtures.

TITANIUM LASTS 20 TIMES LONGER

in this anodizing process

Close-up of moldings held in titanium tips on anodizing rack.

Headlight assemblies held in titanium fixtures.

This automatic anodizing line at Reynolds Metals Company, Louisville, Kentucky, handles aluminum automotive parts on a huge scale. Parts such as window frames, grilles, hood moldings and headlight assemblies, are mounted on racks, which are first dipped in a brightener solution (highly concentrated sulfuric and phosphoric acid), then into an electrolytic bath.

What metal should be used to make the racks? Typical rack life at Reynolds was only 6 days on one anodizing line until titanium was tried. Average rack life is now *120 days.*

For economy in construction, the basic racks are made of aluminum, which is rubber coated. The rack tips or holding fixtures, which must be left bare, are made of Mallory-Sharon commercially pure titanium, riveted or welded in place.

Titanium in this mass production operation yields substantial savings, prevents the disruption of constant replacements. Let us help *you* evaluate titanium wherever you have the problem of corrosion. Write for booklet listing titanium corrosion-resistance data.

MALLORY-SHARON

METALS CORPORATION • NILES, OHIO

Integrated producer of Titanium • Zirconium • Special Metals

Circle 457 on Page 19

CUT COSTS

with the Original Mead

MIDGET AIR CLAMP

(Spring Return Air Cylinder)

In assembly jigs and other multiple applications, this new, low cost pressure unit saves countless man-hours. As a work-ejector in many fixtures, it is unexcelled.

Advantages over mechanical clamps

1 **All Air Clamps** in any set-up can be operated by a single master valve—the "lock-up" and release of assemblies is instantaneous.

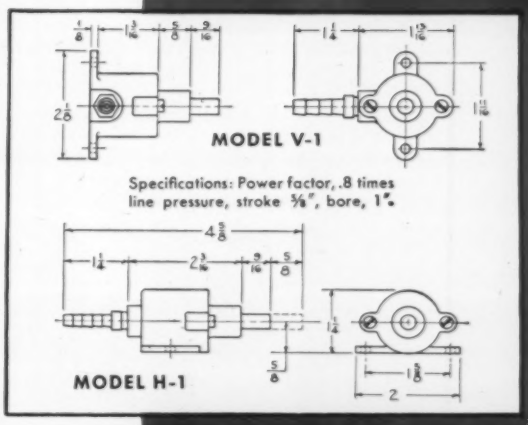
2 **May be installed in cramped corners** difficult to reach with bulky mechanical clamps. Mead Midget is the most compact air cylinder, for its power, on the market.

3 **Equal ram pressure at any point** along stroke, making special, delicate adjustments unnecessary.

4 **Independent group control.** Any desired group of "Midgets" can be controlled independently of any other group in an assembly—as where primary members of the fixture must be locked up before the secondary members.

5 **Facilitates delicate drill operations.** Air Clamps actuated by foot control valves leave operator's hands free to handle the work pieces.

Send for all the interesting facts on these time-tested, superior Midget Air Clamps.



MEAD SPECIALTIES COMPANY

4114 North Knox Avenue • Dept. MD-38 • Chicago 41, Illinois

IMMEDIATE DELIVERY

Single-acting cylinders delivered from stock; double-acting in a few days.

Send Out MEMO Coupon Now For

New MEAD INDUSTRIAL AIR POWER CATALOG

MEAD

AIR OPERATED DEVICES

Memo Coupon

MEAD SPECIALTIES CO.

4114 N. Knox Ave., DEPT. MD38, Chicago 41, Illinois

Send free copy of new, colored MEAD INDUSTRIAL AIR POWER CATALOG describing the complete line of famous Mead air-operated devices.

Name_____

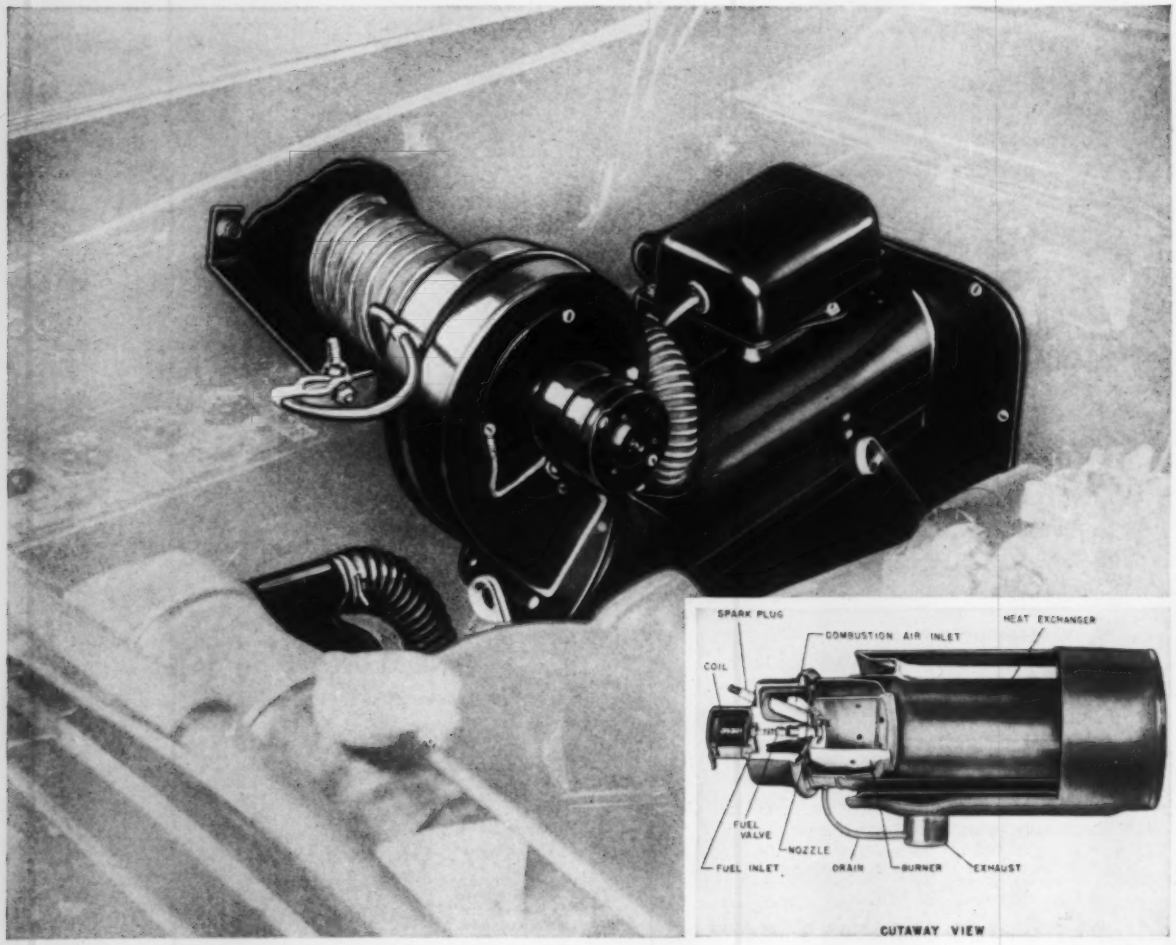
Company_____

Address_____

City_____ Zone____ State_____

Problem-Solving Products from Republic

RESIST HEAT AND CORROSION, INCREASE STRENGTH/WEIGHT RATIOS



CORROSION AND HEAT PROBLEMS were solved in this car heater with the help of Republic ENDURO® Stainless Steel. The gasoline burning heater is manufactured by South Wind Division of Stewart-Warner Corporation, Indianapolis, Indiana.

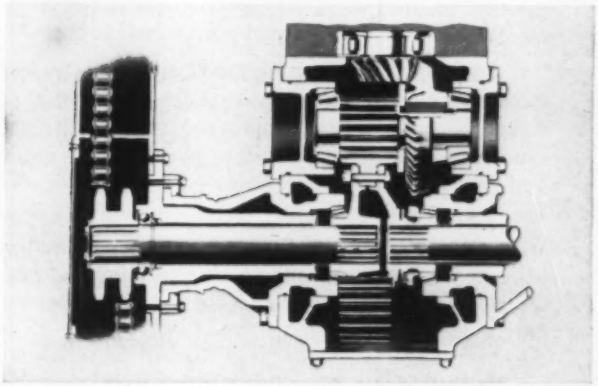
The unit is equipped with its own spark plug and fuel pump which ties into the car's gas line just ahead of the regular fuel pump. The spark plug ignites the gasoline which burns with a continuous flame for regulated periods of time. Thermostatically controlled and rated at 30,000 BTU's, the heater will deliver warm air in five seconds and 180° temperatures in 30 seconds.

ENDURO Stainless Steel, Type 430, was selected for the combustion chamber and surrounding housing because of its low thermal expansion and resistance to corrosion and oxidation at high temperatures (up to 1400°F).

Still another advantage of ENDURO, Type 430, is that it can be readily formed into desired shapes by rolling, bending, pressing, drawing, etc. Its properly prepared surface shows good resistance to atmospheric attack and tarnishing which accounts for its widespread use as molding and decorative trim sections.

Type 430 is but one of more than 35 standard types of stainless steel produced by Republic. Our metallurgists and engineers are always available to work with you in selection, application and processing. Just mail the coupon. There is no obligation.

FOR MAXIMUM SUPPORT, National Seating Company uses Republic ELECTRUNITE® Mechanical Tubing in their "cradle recline" passenger seats. The seat is mounted on 1" O.D. square ELECTRUNITE, bent to a 45° angle for styling. High ductility and superior strength-to-weight ratio of ELECTRUNITE make this operation possible. Rear legs are of ½" x 14-gage round tubing. Besides structural and ornamental advantages, steel tubing eliminates the danger of accidents caused by sharp-edged structural members. Send coupon for complete details on ELECTRUNITE.



OUTSTANDING CORROSION-RESISTANCE even after deep-drawing is provided by Republic Continuous Galvanized Steel. Under the toughest manufacturing conditions the zinc coating will not crack, flake or peel in any forming operation permitted by the base metal. That's why Mackenzie Muffler Company, Inc. uses it in fabricating mufflers for cars, trucks and tractors. Republic Continuous Galvanized cuts manufacturing costs, too. It eliminates costly hot dip operations. Permits continuous uninterrupted production. Available in a wide range of sizes, gages and grades in sheets or coils. Mail the coupon for complete facts.

EXCEPTIONALLY HIGH STRENGTH-TO-WEIGHT RATIOS plus resistance to fatigue, stress, shock and impact are values of Republic Alloy Steels that equipment builders have been relying on for years. Engineers and metallurgists of the Adams Division, LeTourneau-Westinghouse Company, for example, spent thousands of hours on research and testing of all types of steels to find one that would reduce ultimate fatigue to an absolute minimum in the drive axle of their "660" Motor Grader. They selected Republic Hot Rolled 4340 Alloy Steel. This fine steel not only resists fatigue, but also is able to take high torque without a permanent set. Specify Republic Alloy Steels where strength and toughness must resist heavy-duty roughness. Our metallurgists will help you.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

REPUBLIC STEEL CORPORATION
DEPT. C-5124
3130 EAST 45TH STREET • CLEVELAND 27, OHIO

Have a metallurgist call: ☐ Stainless ☐ Alloy
Send more information on:
☐ ENDURO Stainless Steel
☐ ELECTRUNITE Mechanical Tubing
☐ Continuous Galvanized Steel ☐ Alloy Steels

Name_____ Title_____
Company_____
Address_____
City_____ Zone____ State_____

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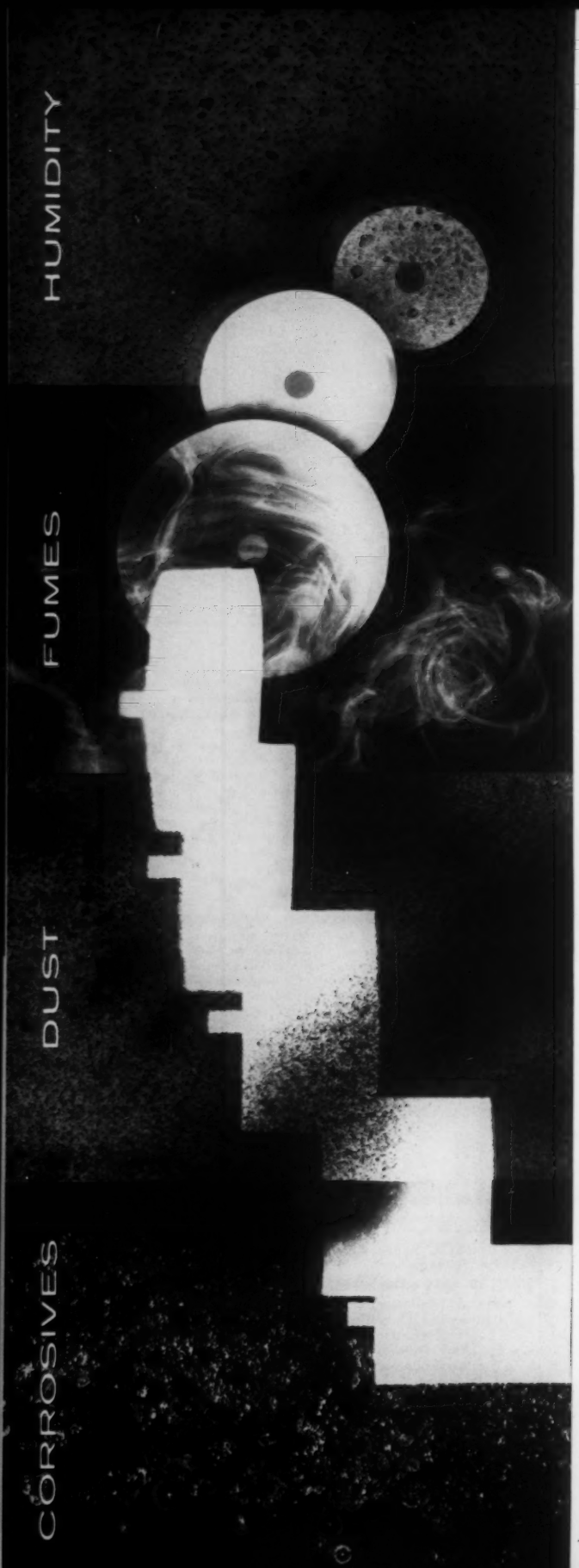


Need a motor impervious to destructive environment?

Call Jack & Heintz—America's leading specialist in *Customized* motors, 1/8 to 3 hp (1/3 to 15 hp in submersible motors). We'll gladly devote as much time as it takes to design a motor that's *impervious* to humidity, dust, fumes, corrosive liquids or altitude. We'll give you a motor that electrically, mechanically and physically fits your product and its environment perfectly.

Customizing electric motors to meet the specific requirements of original equipment manufacturers is *our business*. Because we're organized that way, costs are reasonable.

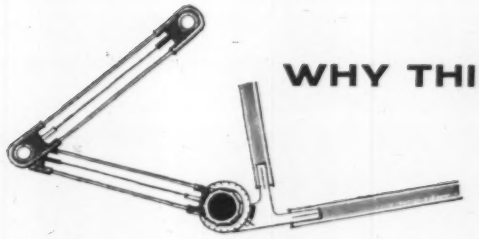
In addition to customizing for environment, we can increase torque, stretch a motor tall, squat it flat, or design-in special ambient temperature rating. We'll make a motor cool, flush, submersible, or give it a special finish. *You name it!*

So go ahead freely! Design your product to do its job. We'll fit a motor to it that will make your product perform the way you want it to . . . look as good as it should . . . last as long as you say it will . . . and sell faster because of it.

FREE! Write for this 24-page booklet. It explains when to specify *Customized* motors, shows examples of design variations, illustrates case histories of *Customized* motors for actual products. Write: Jack & Heintz, Inc., 17626 Broadway, Cleveland 1, Ohio.

JACK & HEINTZ, Inc.
CUSTOMIZED ELECTRIC MOTORS

Circle 460 on Page 19



WHY THINGS RUN SMOOTHER WHEN YOU SPECIFY HYATTS

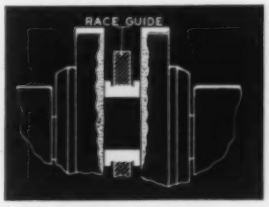
SCRUPULOUS CONTROL OF FINISHING OPERATIONS ASSURES SUPERIOR INNER RACES

The function of a bearing inner race is to provide a fatigue-resistant surface between shaft and rollers. Because of the smaller area of contact between inner race and rollers, as opposed to outer race and rollers, there is a heavier load on the inner race.

Because of this concentrated load, *the inner race is the critical member of any roller bearing*, from the fatigue life standpoint.

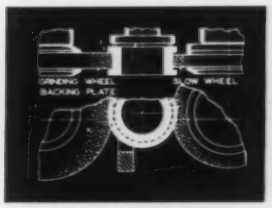
To assure the finest possible inner races, and therefore smoother, longer performance, HYATT exercises scrupulous control over the four critical finishing operations detailed at the right. It's another good reason why so many designers prefer HYATTS.

You will find full selection and application data in HYATT Catalog 150, or call your nearest HYATT Sales Engineer.
Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey, Pittsburgh, Detroit, Chicago and Oakland, California.



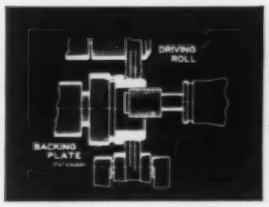
1 DOUBLE END GRIND

Grinding sequence is important. Ends are first faced off *square and parallel* to serve as accurate reference during later work. Hyatt double end grind provides excellent control of parallelism.



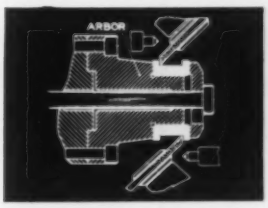
2 CENTERLESS PATHWAY GRIND

This Hyatt-pioneered process holds taper and out-of-round to minimum, produces as nearly perfect cylinder as commercially practical. Backing plate against ground end insures accuracy.



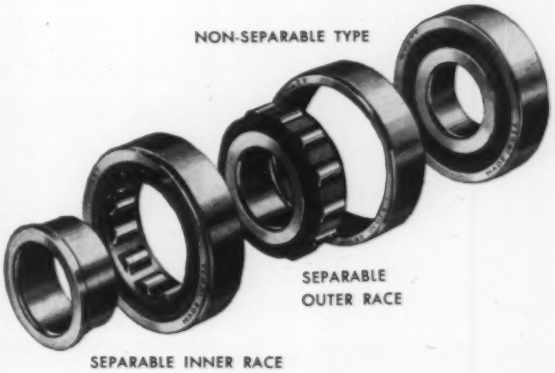
3 CHUCKLESS BORE GRIND

Here again, the centerless process assures a bore concentric with pathway, with minimum wall variation, by removing stock from high spots passing between drive roll and grinding wheel.



4 FLANGE GRINDING

To assure that they will run true with roller pathway, all flange faces are also ground using squared ends for reference. This provides vital even contact with ends of rollers.

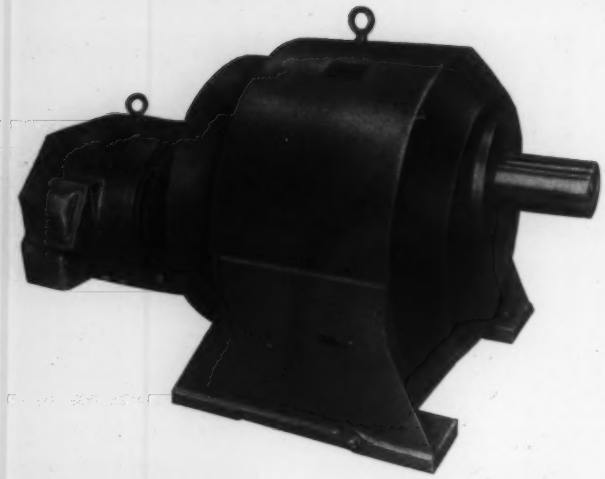


THE RECOGNIZED LEADER IN CYLINDRICAL BEARINGS

1908–1958 GM FORWARD FROM FIFTY

HYATT HY-ROLL BEARINGS FOR MODERN INDUSTRY

Circle 461 on Page 19



NOW . . . GREATER CAPACITY than any other standard gearmotor . . . and in smaller space!

Capacity up to 200 hp loads, with ratios up to 440:1—that's what you get with the new Philadelphia Type "G" Gearmotor. No other standard gearmotor or in-line reducer on the market offers such high capacity and rugged construction. Yet its compact design gives you the smallest possible power package for any job. The Type "G" is the answer for any application demanding heavy duty, continuous service performance.

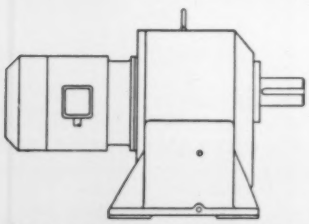
Compact Design. "Shaft-in-line" design makes the new Type "G" Gearmotor more compact and permits complete flexibility in mounting. *Result:* substantial savings in space required. You can even mount the Type "G" without a base plate.

Helical Gearing supports larger loads with maximum power efficiency (96-98%)—assures silent operation, increased strength, longer life. Teeth are crown shaved and induction hardened for optimum performance.

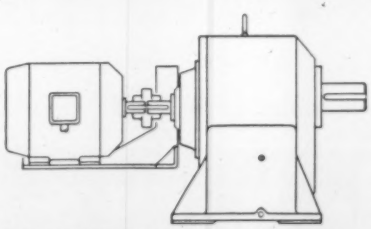
The Type "G" Gearmotor is an extension of the famous Philadelphia Gearmotor Line. It is available as a reducer, gearmotor with motor mounting bracket, or standard gearmotor with flange mounted motor. For complete information, write for Bulletin GM-57-B, Philadelphia Gear Works, Erie Ave. and G Street, Philadelphia 34, Pa.

Offices in Principal Cities • Virginia Gear & Machine Corp., Lynchburg, Va.

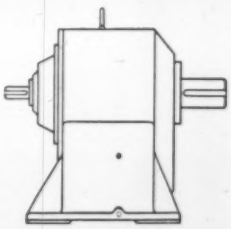
phillie gear®



INTEGRAL GEARMOTOR (Flange Motor)

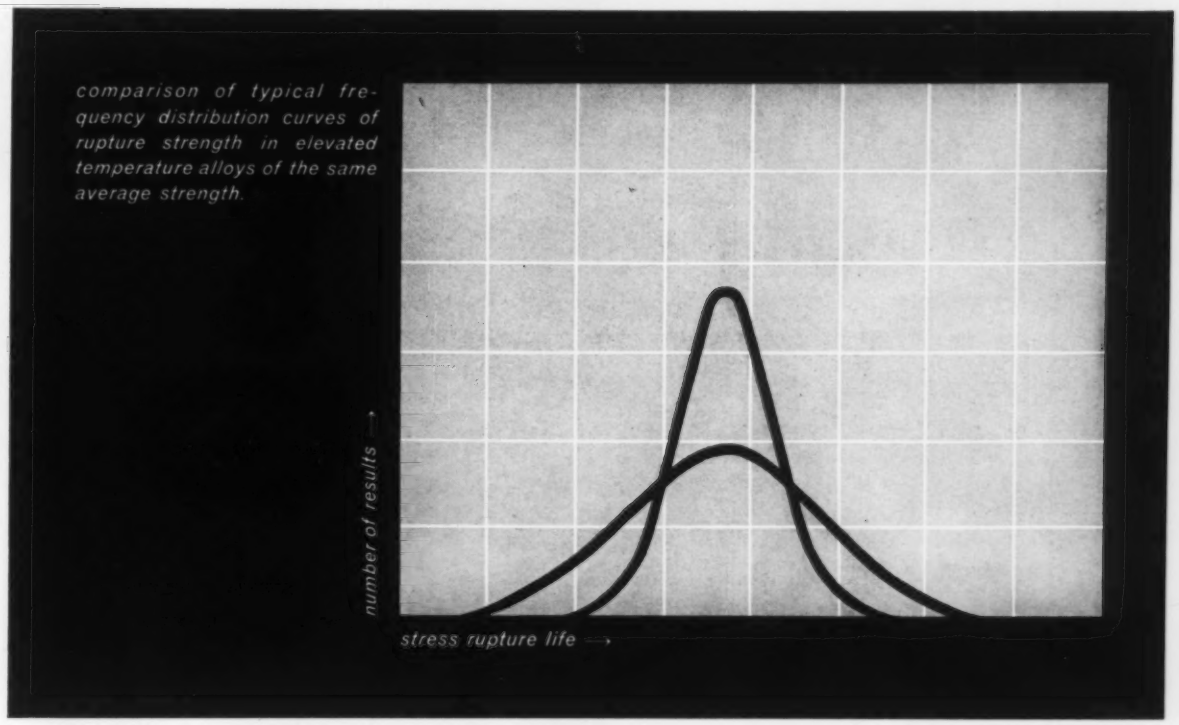


UTILITY GEARMOTOR (Foot Mounted Motor)



IN-LINE REDUCER

Circle 462 on Page 19


comparison of typical frequency distribution curves of rupture strength in elevated temperature alloys of the same average strength.
number of results →
stress rupture life →

why consistency is important to every designer who uses elevated temperature alloys

The broader curve is characteristic of elevated temperature alloys generally used today. Its shape shows parts made from this alloy will have widely varying service lives.

The steep curve is typical of Carpenter alloys for elevated temperature service. It shows one reason why Carpenter alloys are becoming so widely used — they're so consistent in performance.

Fabrication properties are just as outstanding. Forge shops, fastener makers, engine builders report better finishes and fewer rejects with Carpenter high temperature alloys than with similar types produced by others. Carpenter alloys have gained an enviable reputation for exceptional cleanness, forgeability and machinability wherever they are used.

Predictable performance and outstanding fabrication properties of Carpenter elevated temperature alloys are made possible by the most exacting standards of quality control, typical of Carpenter's leadership in the technology of specialty steels.

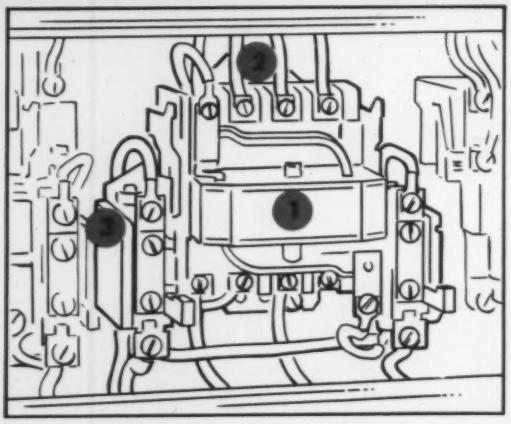
Write today for your copy of the new booklet, "Carpenter Alloys for Elevated Temperature Service". Or ask the Carpenter representative who calls on your company. The Carpenter Steel Company, 120 W. Bern Street, Reading, Pa.

Carpenter STEEL

Improved alloys for elevated temperature service

Circle 463 on Page 19

Circle 522 on Page 19→



1. **42% SMALLER SIZE.** The new 100-Line General Electric magnetic starters (Size 0 and 1) are only as high as G-E 4- and 6-pole relays. You no longer waste space on your panels.

2. **STRAIGHT-THROUGH WIRING.** All you do is insert your leads into the pressure-type terminals and tighten. They are on the front of the new G-E magnetic starter — easy to reach.

3. **ADJUSTABLE OVERLOADS.** A new finger-tip adjustment of the overload relay trip setting allows easy adjustment between plus or minus 15% of the nominal heater rating.

NEW G-E SIZE 0 AND 1 MAGNETIC STARTERS

Cut cost by reducing panel space and assembly time

BECAUSE THEY'RE 42% SMALLER — FEATURE STRAIGHT-THROUGH WIRING, FRONT CONNECTIONS

These new, radically different 100-Line General Electric magnetic starters have been designed to help you save panel space and assembly time.

SAVE PANEL SPACE. The new starter is 42% smaller — now approximately the same height as G-E 4- and 6-pole relays. When starters and relays are mounted side by side, you no longer waste space below the relays. G.E.'s straight-through wiring and cooler operation mean you need only ½ inch on each side of the new starter. The coil inrush current has been reduced so you can use a 40 volt-amp control transformer. You also have your choice of vertical or horizontal mechanical interlocking on reversing starters. The savings in panel space also help meet the new JIC specifications.

SAVE ASSEMBLY TIME. The new, 50% lighter weight G-E magnetic starter is fast and simple to install and connect. Straight-through wiring means you attach leads to the terminals at the top and bottom of the starter — no more run-a-round wiring to take extra time and space. You mount the starter by simply sliding its key holes over three mounting screws on the panel. This new General Electric magnetic starter will easily cut your assembly time.

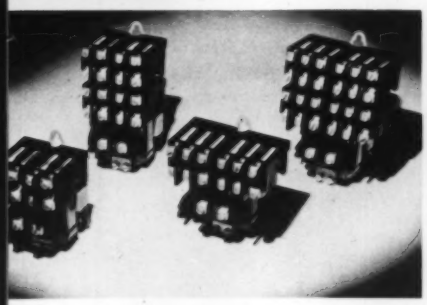
Your customers will enjoy extremely quiet, dependable operation — and appreciate the fast inspection and the 20-second disassembly, made possible by "snap-slide" construction. They'll also like the space savings your smaller, more compact panels provide.

Like more information? Contact your nearby General Electric Apparatus Sales Office, or write to Section 731-15, General Electric Co., Schenectady, N. Y., and ask for bulletin GEA-6611.

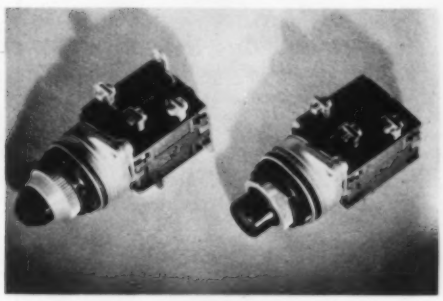
General-Purpose Control Dept., Bloomington, Ill.

Progress Is Our Most Important Product

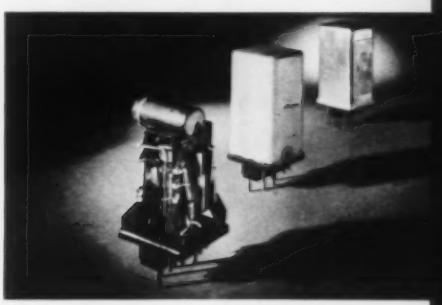
GENERAL ELECTRIC



MACHINE TOOL RELAYS have front connected terminals, are easy-to-wire from four directions, and are also available in latched-in forms.



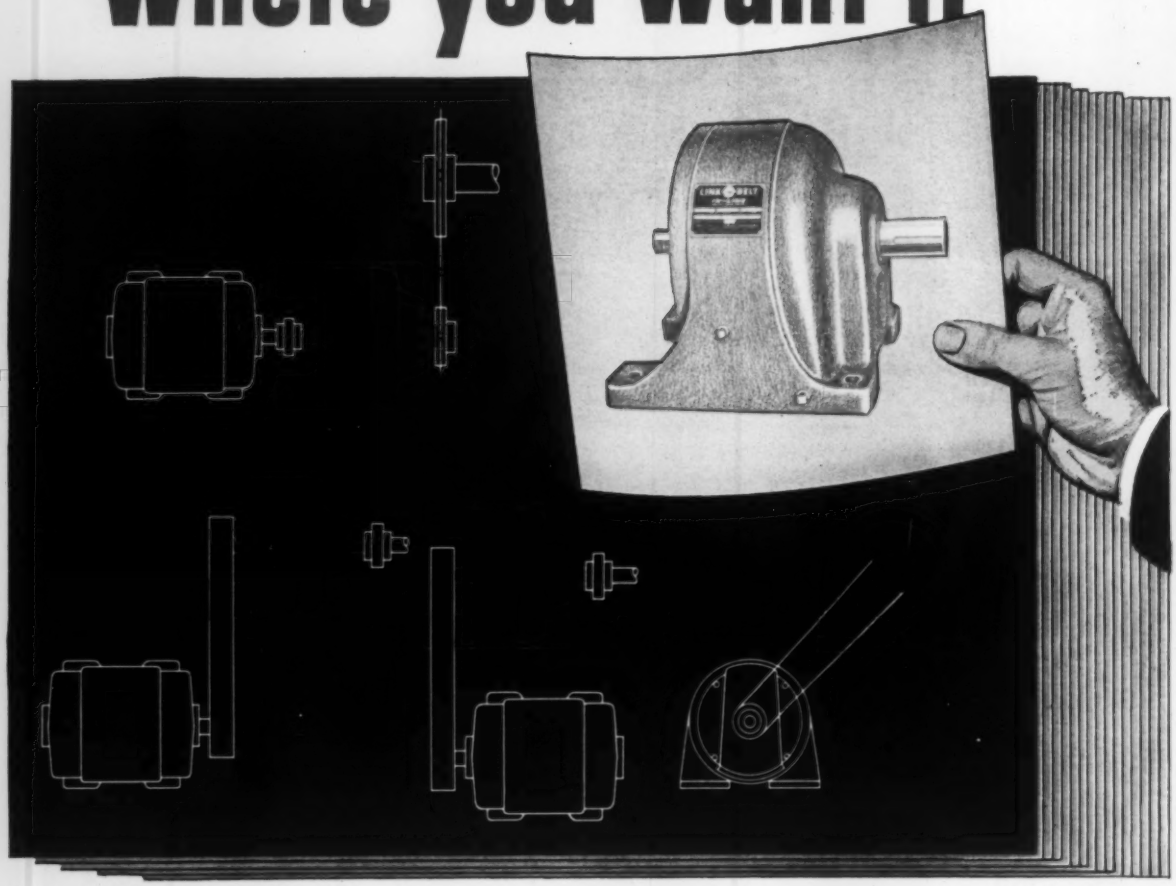
OIL-TIGHT PUSH BUTTON UNITS. The new push to test unit checks for burned out bulbs — the new illuminated unit reduces panel space 50%.



STATIC CONTROL components, in easy-to-use plug-in form, provide reliability for critical jobs. Photo shows three steps of encapsulation.

Here's a SPEED REDUCER that lets you

mount the motor where you want it



Versatile **LINK-BELT** *In-Line helical gear drives give wide latitude in drive arrangement*

Make the most of mounting space with quiet, cool-running, oil-tight Link-Belt In-Line helical gear drives. No need to direct-connect the motor. Where layout requirements so dictate—or to achieve even higher reduction at low cost—a chain or gear drive can be used in between. Location of input and output shafts on same planes makes installation easy, saves space.

Consists of a streamlined housing with double, triple or quadruple reductions up to 206 hp. Call your nearby Link-Belt office. Ask for Book 2651.

BOOK 2651

LINK-BELT

SPEED REDUCERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,805-A

Circle 529 on Page 19

Waldes Truarc GRIP RINGS Replace Expensive Parts... Reduce Manufacturing Costs...Eliminate Rejects

WALDES TRUARC SERIES 5555 GRIP RING*

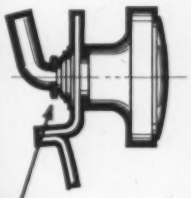
application: external for shafts

range: .077 in. — .755

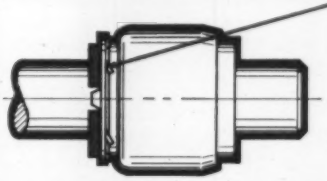
The Waldes Truarc Grip Ring requires no groove, holds fast by friction forces, can be used again and again. It provides a positioning shoulder secure against moderate thrusts or vibration. The ring's unusually large radial width exerts considerable frictional hold against axial displacement.

*U. S. Pat. No. 2,574,034

Rings cut costs 33%, eliminate rejects



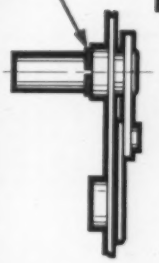
B & J Tool uses series 5555 grip ring to secure parts of damper control made for Vulcan Radiator. Shaft formerly was machined down to provide coil spring shoulder, often broke during bending operation. (Rejects ran as high as 80%!) New design eliminated rejects and field failures, cut production costs 33%.



Rings save $300 per die, $.03 unit

Ray Oil Burner Co. uses a Truarc series 5555 grip ring in fuel pump drive shaft to position seal and drive it to assure continuous rotation with shaft. Original design used complicated die-cast collar and driver which required special groove and shoulder. Savings: $300 per die for each size manufactured, $.03 per part.

Rings save $32.42/M:



Swift Business Machine Co. replaced collars and set screws in hollow shaft assembly of its adding machine with series 5555 grip rings, saving $32.42 per 1000 units. Rings require no groove, make possible positioning adjustments without slippage encountered when set screws were used.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get

Statistically Controlled Quality from engineering and raw materials to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today . . . let our Truarc engineers help you solve design, assembly and production problems . . . without obligation.

WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C.1, N.Y.

Please send new, descriptive catalog showing all types of Truarc rings and representative case history applications.

(Please print)

Name_____

Title_____

Company_____

Business Address_____

City_____ Zone____ State_____

M D030

Consult the Yellow Pages of Your Telephone Directory for Name of Local Truarc Factory Representative and Authorized Distributor.

Circle 464 on Page 19

When you buy from Ohio Seamless

YOU PRESS THE BUTTON
OHIO SEAMLESS
DOES THE REST

Buying steel tubing from Ohio Seamless doesn't cost—it *pays*. Our minimum quantities are generally smaller than you may realize . . . often as small as 100 to 150 feet, in certain seamless grades and sizes.

When you buy from us, you're dealing with tubing *experts* . . . men who can recommend the *exact* Ostuco Tubing to suit your product and processes. There's no compromise on analysis, size, anneal, etc.

Advantages of buying from Ohio Seamless multiply, the closer you examine them. Our single-source service eliminates headaches of interplant shipments . . . possible errors . . . multiple purchase orders and invoices. Ohio Seamless keeps your production lines humming because you get *precisely what you want.*

For proof, contact our nearest sales office or the plant at *Shelby, Ohio—Birthplace of the Seamless Steel Tube Industry in America.* AA-7116

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CANADA: RAILWAY & POWER ENGR. CORP., LTD.

EXPORT: COPPERWELD STEEL INTERNATIONAL COMPANY
225 Broadway, New York 7, New York

FIFTY YEARS
OSTUCO TUBING
1908 1958

OHIO SEAMLESS TUBE DIVISION
of Copperweld Steel Company SHELBY, OHIO

Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging

Drawings up to 24" x 36" may be reduced onto 12" x 18" paper masters by XeroX® Model 1218 copying equipment, above, and multiple copies run off on an offset duplicator. Inset shows volume comparison: Rear stacks have 350 blueprints each, in D, C, B, and A sizes. Foreground has same, reproduced by xerography and offset duplicating.

thanks to XEROGRAPHY...

Handy, low cost, 12"x18" copies... *hundreds, if needed, in minutes*... of drawings up to 24"x36"

Now, thanks to xerography—the clean, fast, dry, electrostatic copying process—you can get convenient 12" x 18" reductions—hundreds, if needed, in minutes—of original engineering drawings up to 24" x 36".

XeroX® Model 1218 copying equipment provides a fast, economical method of preparing inexpensive 12" x 18" offset paper masters for fast, economical duplicating.

Drawings are reduced with fine legibility and without loss of detail to the 12" x 18" confines of the master. Medium-size drawings (12" x 18") may be copied size to size, while several small drawings at a time may be copied in their original size or enlarged individually to 12" x 18". After use, masters may be filed for runoff of additional copies when needed.

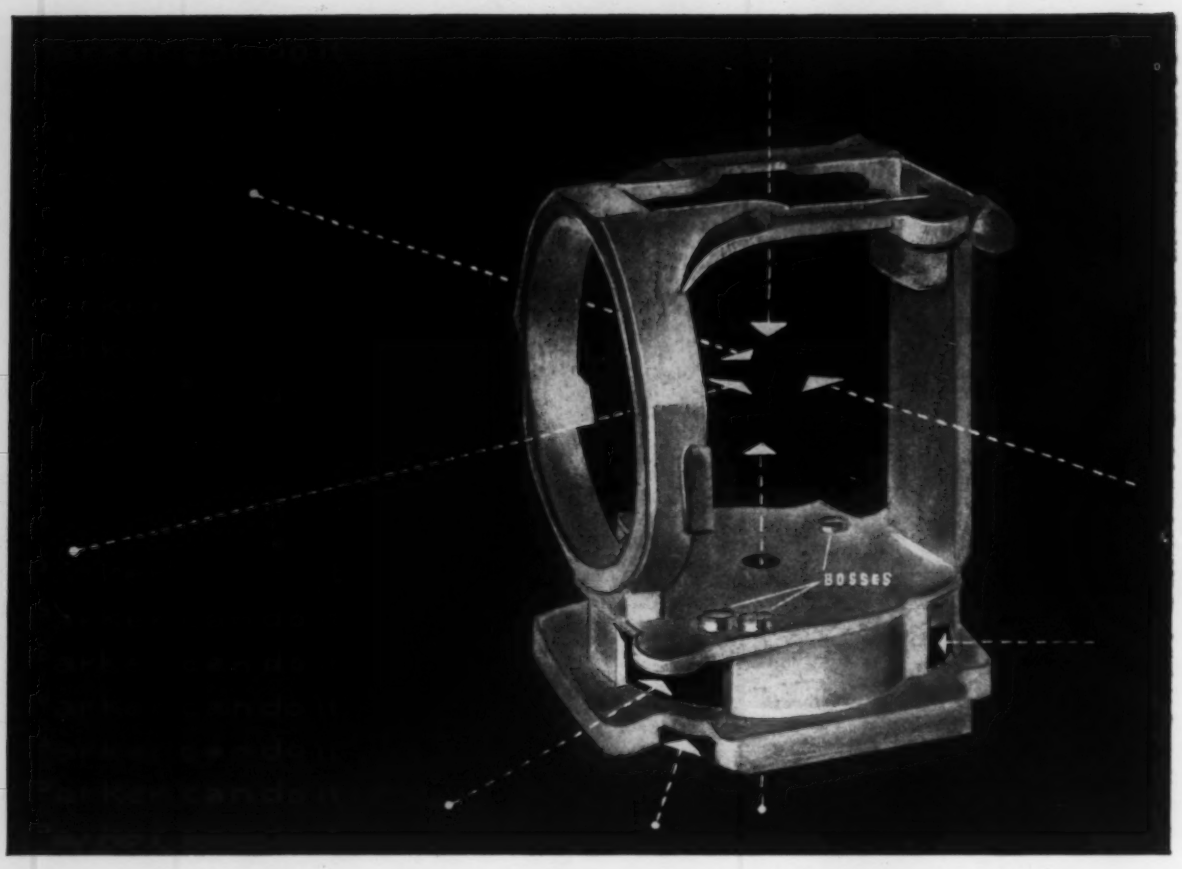
XeroX Model 1218 copying equipment permits the use of precut rather than roll paper, thus eliminating hand-shearing operations. The reduced size and thinner stock save filing space as well as folding and unfolding time. The runoff copies are precisely like the original—clean, sharp, and easy to read.

Write for proof-of-performance folders showing how companies of many kinds are saving thousands of dollars yearly, speeding engineering-drawing duplicating by xerography.

THE HALOID COMPANY
58-183X Haloid Street, Rochester 3, N. Y.
Branch offices in principal U.S. and Canadian cities

HALOID XEROX®

Circle 466 on Page 19



Coring Too Intricate For Die Casting?

-----not at Parker

PARKER SALES ENGINEERS

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Warren G. Olson • 420 East Linn Street

CHICAGO 49, Ill.
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Box 26

Because of intricate coring—together with internal bosses—sand casting seemed to be the only way to make this part. Necessary finish machining, however, boosted costs too high.

Then Parker die casting engineers tackled the job—and licked the coring problem. The result: a part with greater density, closer tolerances, better surface finish, no finish machining and—best of all—*much lower cost per unit.*

Here is just another example of the way Parker-engineered die castings save you money.

Parker has been a leader in die casting for over 50 years—an old hand with new ideas. This skill and experience can solve problems—and save money—on *your* component parts. Just call the nearest Parker sales engineer or send your prints to the factory direct.

Parker White Metal Company • 2153 McKinley Ave., Erie, Pennsylvania

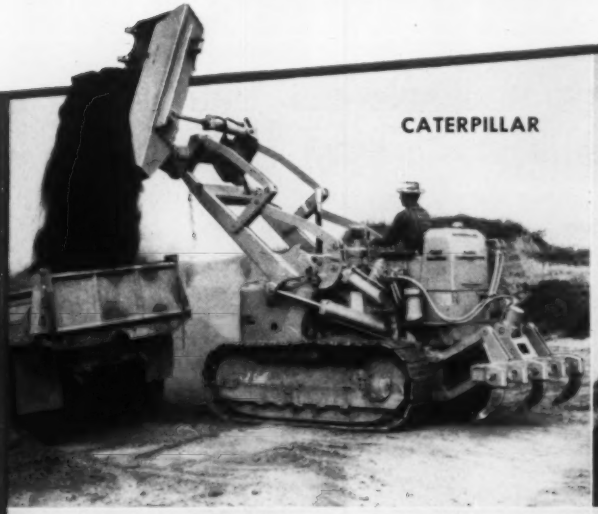
PARKER

high pressure ALUMINUM and ZINC die castings POWDERED METAL PARTS

Circle 467 on Page 19

BLOOD BROTHERS Universal Joints

"get the power through" to make our highways come sooner . . .



CATERPILLAR

INTERNATIONAL

MICHIGAN

TRACTOMOTIVE

It's a rough, tough, shock-and-strain life for the average 'dozer and loader. But machines like these are ready for it. Part by part, they've had long life engineered right in from the start.

Blood Brothers Universal Joints, for example, are one of the rugged, dependable components you'll find . . . selected for their field-proved ability to withstand punishment.

On these machines—and many other kinds of road-building equipment—Blood Brothers Universal Joints "get the power through" dependably. It's one of their vital functions to help make our highways come sooner.

If you build heavy-duty equipment, write for Bulletin 557—or call on our engineers for suggestions.

UNIVERSAL JOINTS
AND DRIVE LINE
ASSEMBLIES

ROCKWELL SPRING AND AXLE CO.

Blood Brothers Machine Division

ALLEGAN, MICHIGAN

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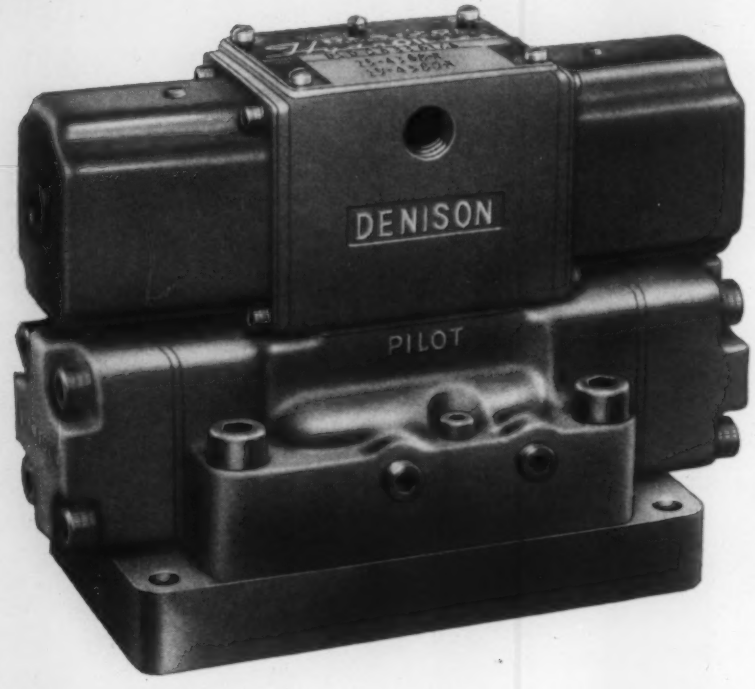
Circle 468 on Page 19

NEW
from
DENISON

4-WAY VALVE

Pilot-operated, solenoid-controlled for hydraulic systems up to 3000 psi



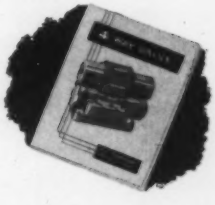
SHOCKLESS CONTROL is assured with Denison's new line of 4-Way Valves for any directional control requirement.

Designed to provide directional control of oil flow up to 30 gpm—pressures up to 3000 psi, and all porting and positioning combinations—these new valves offer exceptional design versatility to Hydraulic Engineers because:

1. They meet all JIC requirements.
2. Over-all length is shorter than any other comparable valve.
3. Shortest solenoid power stroke increases operative force.
4. Special built-in check provides pilot pressure without adding another valve to the system.
5. No bulky, external chains to catch on equipment or personnel. Rugged, drawn-steel solenoid covers are secured to body with internal retaining cords.
6. Oil-enclosed solenoids are available.
7. Direct current operation also available.
8. Interchangeable parts simplify service and model changes in the field.

DESIGNERS ENGINEERS!

Send for Bulletins VD-7 and VD-8



for full details write

DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1240 Dublin Road • Columbus 16, Ohio

HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

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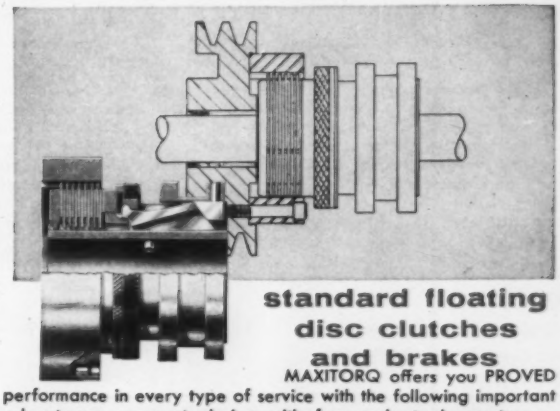
DENISON HydrOILics

Circle 469 on Page 19

if your design calls for CLUTCHES

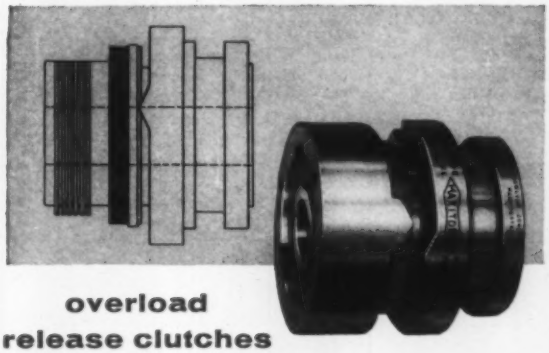
MAXITORQ electric clutches and brakes

PROVED design, Floating Disc action is fast and positive, with no heating or drag in neutral. Compact, simple, with few moving parts. For WET or DRY operation: Electrical operating unit DOES NOT REVOLVE; no brushes or slip rings. Use easily replaced standard Disc-Pac. Requires no adjustment. Wide range of standard sizes, single and double types. All sizes rated 80 watts, operate on 110 V, A.C., rectified to 90 V, D.C. Other voltages on special order.



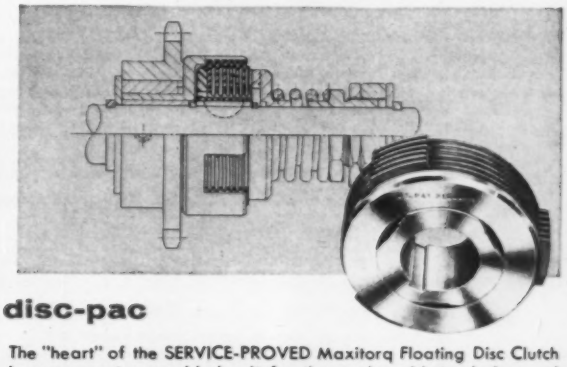
standard floating disc clutches and brakes

MAXITORQ offers you PROVED performance in every type of service with the following important advantages: compact design with few and sturdy parts . . . floating neutral with no heating or drag . . . positive engagement or release with light pressure . . . manual assembly and adjustment . . . full power transmission . . . full range of sizes and types . . . supplied as complete, easily installed units.



overload release clutches

One of the simplest and most efficient methods of providing a DEPENDABLE and easily adjusted overload release on machines requiring this safety feature in addition to a clutch. Incorporate all the advantages of MAXITORQ Floating Disc design plus automatic and complete release upon overload. Proved in service. Available in a wide range of sizes.



disc-pac

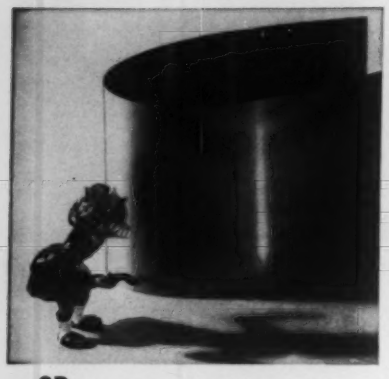
The "heart" of the SERVICE-PROVED Maxitorq Floating Disc Clutch in a compact, assembled unit for those who wish to design and build their own clutch mechanisms. Supplied as complete units ready for use in 8 diameters 2" to 8", up to 800 ft. lbs. capacity. Also useful as a multiple disc brake or torque limiting device.

Write for complete data and specifications on any or all of the above. If you have a problem involving clutch applications, consult us. A letter or phone call will receive prompt attention. Dept. MD-3.

M THE CARLYLE JOHNSON MACHINE COMPANY, MANCHESTER, CONN.

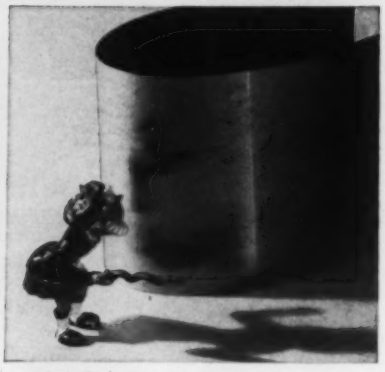
No matter which *FINISH* you like—you can buy it in

MicroRold® QUALITY STAINLESS STEEL



2D—A silvery white, but non-lustrous, surface produced by annealing and pickling cold reduced material. Steel sheets & strip in this condition are most ductile and the surface holds lubricant well for severe drawing operations.

2B—Steel in the 2D condition which is subsequently rolled on a "skin pass" or temper mill. The surface acquires a bright finish from the polished rolls. This surface is somewhat more dense and hard than 2D and is a better starting surface for later finishing and buffing operations.



No. 3—This surface is made by grinding with a No. 100 abrasive. This surface is smooth but not as reflective as 2B.

No. 4—A finer finish than No. 3 made by grinding with a No. 150 abrasive. Like No. 3, this surface is easily blended with hand grinders after forming, drawing or welding.

No. 7—Good reflectivity and brilliance made by polishing with a No. 400 abrasive. This semi-mirror finish must be protected during fabrication by adhesive paper or strippable plastics lest the finish be marred beyond repair.

BRIGHT—A highly reflective surface made by cold reducing with highly polished, glass-hard rolls. This finish is only available in Type 430 stainless.

These are our standard surface finishes that are available in types 201, 202, 301, 302, 304 and 430 except Bright which is type 430 exclusively.

These finishes are regularly supplied in sheet and coil form in widths up to 48 inches.

Since Nos. 3, 4, 7 and 430 Bright are smooth reflective surfaces, they are not recommended for severe drawing without special precautions as the mill finish may be marred. Applications such as dairy machinery, kitchen and restaurant equipment and architectural decorative work require only local forming, so these highly polished surfaces are not greatly disturbed. All mill polished sheets are carefully packed to avoid handling imperfections. Protective adhesive paper can be specified by the buyer when needed.

For specific information on recommended surface characteristics for a particular stainless steel sheet and strip application, address your request to our Product Development Dept.

WASHINGTON STEEL CORPORATION · MicroRold · STAINLESS · SHEET & STRIP

Washington Steel *Corporation*

Producers of Stainless Sheet and Strip Exclusively

3-E WOODLAND AVENUE, WASHINGTON, PA.

Help Satisfy the "Low Cost" Requirements of Your Design

GITS

World's Largest Selection of

LUBRICATING DEVICES

LUBRIKIT . . . An assortment of 95 oil cups of 29 different types. Gits sales records show these oilers are most used for replacement and maintenance. Contents of each separate bin are clearly described on Inside Cover.

Special Introductory Price
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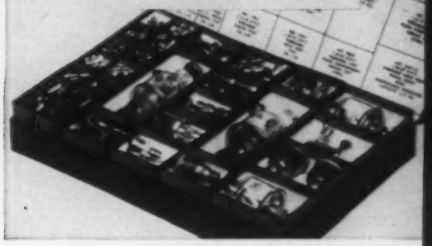
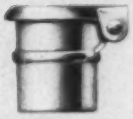


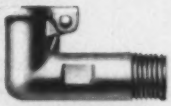
OIL HOLE COVERS

Style R — No. 304
Shoulder Drive



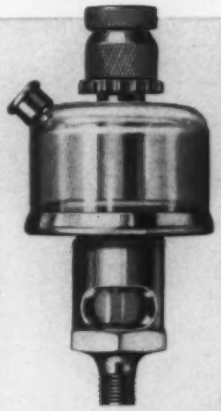
Style G — No. 505
Beaded Drive

Style GB — No. 527
Ball Valve



Style L — No. 1204
Brass Elbow (Threaded)

SIGHT GRAVITY FEED OILERS

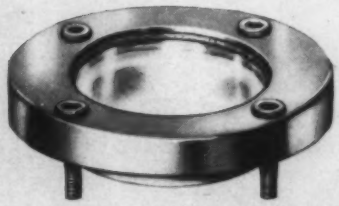


Rate of oil flow regulated by needle valve, directly observed through sight glass in stem. Shut-off knob does not affect needle valve adjustment. Visible oil supply. Non-breakable. Tops in convenience and dependability, at low cost. Style NFU—No. 3602-A.

GEAR CASE GAUGES

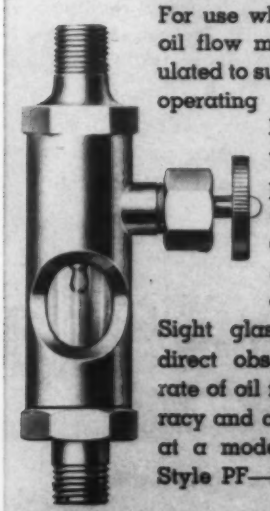
This oil gauge plug permits instant checking of oil level within a transmission or gear case. For use where construction permits insertion in tapped hole. A valuable addition to any such equipment — at very low cost. Style BW—No. 4042.

GEAR CASE GAUGES



Screw mounted, to set flush. Glass port is backed with white enameled reflector, to make oil level (in gear case or transmission) readily visible, even in dim light. Style CW — No. 4032.

SIGHT GAUGES



For use where rate of oil flow must be regulated to suit changing operating conditions. Needle valve permits extremely accurate adjustment of oil feed. Sight glass provides direct observation of rate of oil flow. Accuracy and convenience at a moderate price. Style PF—No. 4290.

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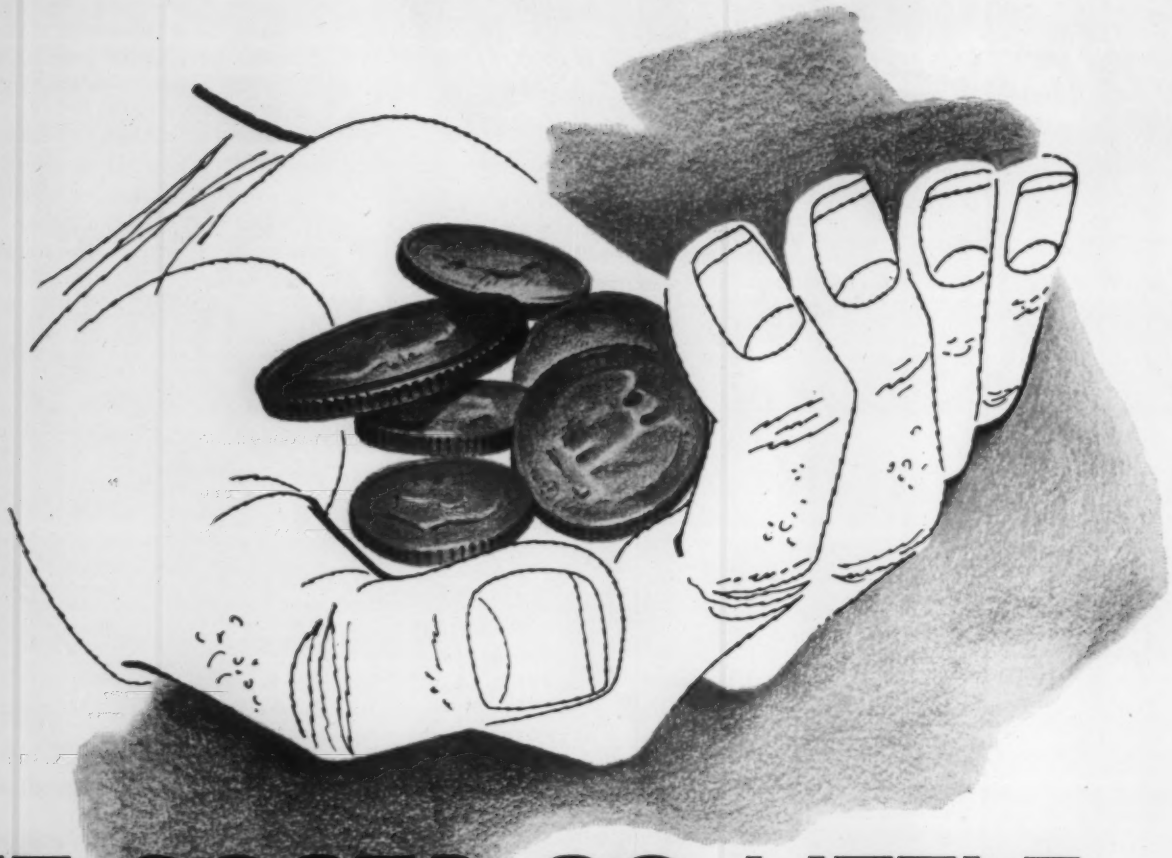

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Full information on the many advantages FAWICK can provide for your machines is available in Bulletin 500-A which will be sent on your request. Contact your nearest FAWICK representative or the Home Office, Cleveland, Ohio.

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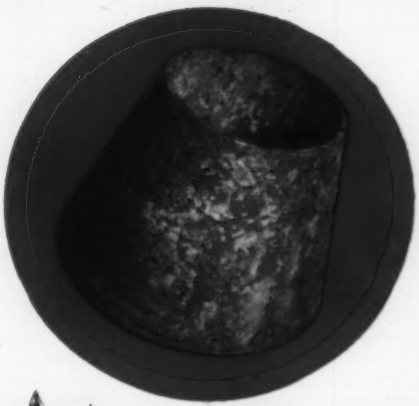

ONE-PIECE WELDED CONE FOR THE HOT SPOT

This is the vital nozzle cone of the Martin Mace guided missile. American Welding was able to form it in one piece from ¾-inch plate (FS-1020) and arc weld the joint to produce a tapered cone with a major diameter of 25 inches and a minor diameter of 15 inches. After heat treating and X-ray testing, it proved to be better and more economical than nozzle cones produced by the previous method of forming in two halves.

If you require a circular product and it's metal — call American Welding first.

New Products Catalog. Write today for 20-page catalog of circular products which American Welding can form, weld and machine for you.

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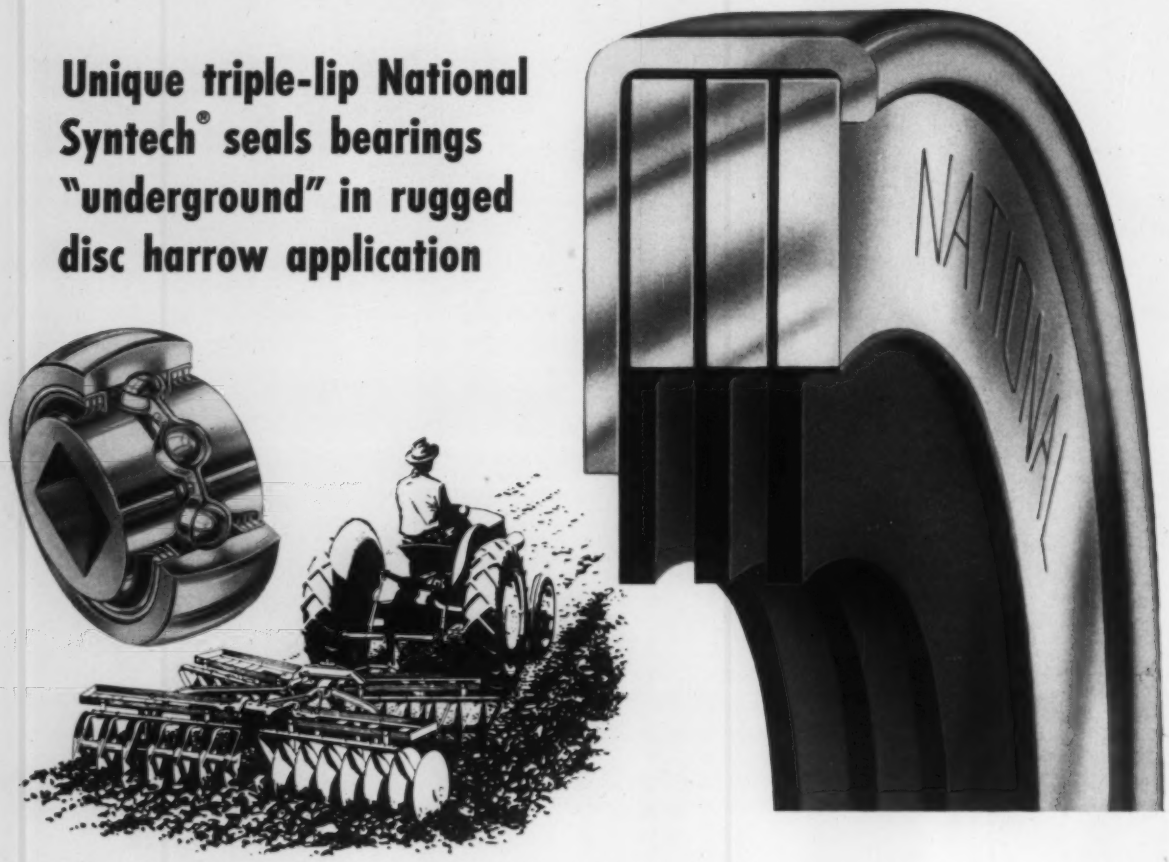
AMERICAN WELDING

Unique triple-lip National Syntech® seals bearings "underground" in rugged disc harrow application



Low cost, easily installed
Excludes dirt, mud and water
Ideal for permanently lubricated bearings
Effective after 4,000 test hours

The Triple-Lip Syntech seal, pioneered by National, provides a new standard of bearing protection for equipment operating in severe dust, dirt, mud and water conditions.

The seal is rugged and extremely simple in design. It consists of three identical synthetic rubber sealing members bonded to metal washers and enclosed in a rigid steel outer case. Use of the "straight" Syntech sections keeps torque low, simplifies flush lubrication, and permits the seal to accept a high degree of runout and misalignment where needed.

For complete information, call your National Applications Engineer or write direct

NATIONAL SEAL
Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
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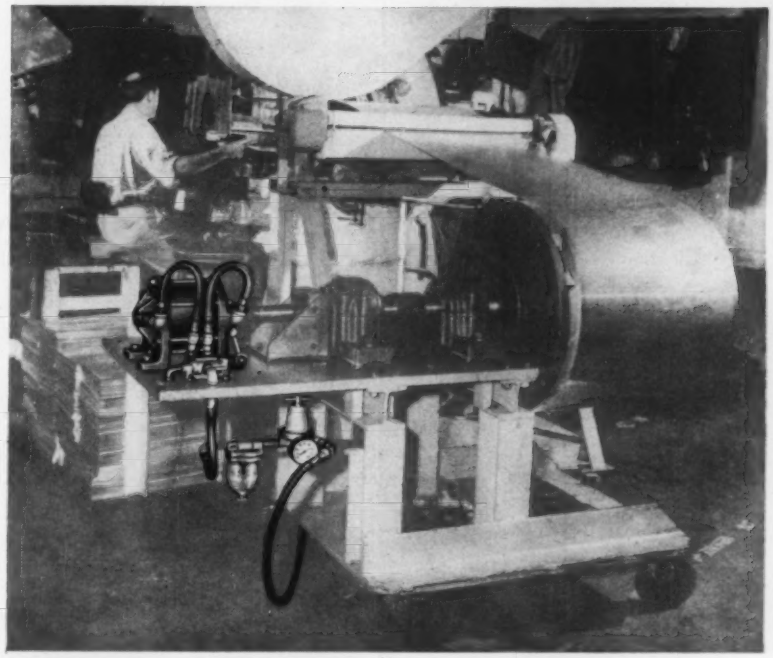
Circle 475 on Page 19

YOU CAN TAILOR AIR CONTROL UNITS FOR ANY JOB WITH STANDARD SCHRADER PRODUCTS



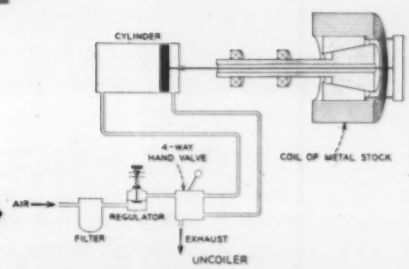
Every day more designers, more engineers are solving problems with air. They're planning air systems to hold, clamp, move, trip, feed, eject . . . from tiny parts to 3000-pound coils.

Air is versatile, economical, safe, fast. And when you select your components from Schrader, you choose from the most complete line of air products. Whenever you mechanize manual operations, or automate mechanized ones, investigate air. Schrader engineers are prepared to help you like we did here.

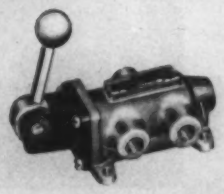
HERE'S AN INTERESTING SHOP PROBLEM SOLVED BY SCHRADER: How to strip steel from 3000-pound coils:

Radial jaws actuated by a Schrader air cylinder hold the coil firmly on an expanding mandrel. A 4-way valve and a pressure regulator govern the air power. Wherever uncoiler is needed it is plugged into an air line with quick-acting couplers. Opening the 4-way valve actuates the cylinder and the operator works freely at this machine. Just imagine the time and trouble, this one idea saves this company!

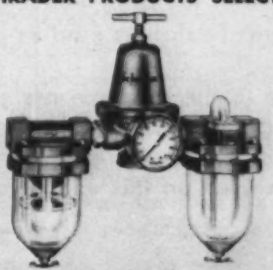
Here's the hook-up



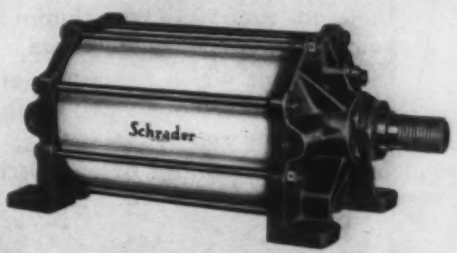
HERE ARE SOME OF THE SCHRADER PRODUCTS SELECTED FROM THE HUNDREDS OF SIZES AND TYPES:



Four-Way Hand Valve operates through a simple hand lever. Can also be operated automatically or with pedal.



Lub-air-ator: special 3-part unit that lubricates, regulates, filters air line. Easily adjusts pressure.



Double Acting Cylinder: is used here for its powerful two-direction stroke. For one way powered stroke, use single acting cylinder with integral spring return stroke.

We can help you put Schrader Products to work just as profitably and our Distributors are conveniently located for fast delivery. Information is available by writing directly to us—

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Schrader®
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QUALITY AIR CONTROL PRODUCTS

Circle 476 on Page 19

HEIM *Unibal*® Rod Ends

...in good company...

The new General Electric J79 jet engine has the highest thrust-to-weight ratio of any aircraft power plant in production. The engine is rated in the 10,000-pound thrust class.

Variable stators are used for the first time in a flying jet engine, which in a mechanically simplified way, and with far less weight, accomplish the same thing that the dual rotor does in other current engines. The device provides a smooth flow of air inside the engine and eliminates the "stall barrier" problem.

HEIM UNIBAL SPHERICAL BEARINGS and ROD ENDS supply the exact type of linkage, mounting, and degree of misalignment correction required by this engine, and The Heim Company is proud of its contribution to the success of the GE J79.

There are over 200 Unibal Rod Ends assembled with the variable pitch stator blade operating levers.

There are over 50 LS type Unibal Spherical Bearings used as pivot points for the inlet guide vanes.

The bearings which mount the engine to the airframe are three Heim Unibal cartridge units. These bearings carry the entire weight of the engine *and its thrust*.

Other Heim bearings of various types used on this engine bring the total to around 500.

* * * *

The load carrying capacity of Unibal spherical bearings is very high. They are applicable in any linkage where motion must be transmitted at constant or varying angles. They are ideal as supports to any device which is subject to mechanical or thermal deflection.

COMPLETE CATALOG AVAILABLE / SOLD THROUGH THE LEADING BEARING DISTRIBUTORS

THE HEIM COMPANY, FAIRFIELD, CONNECTICUT

Circle 477 on Page 19

MOLDED CASE CIRCUIT BREAKERS

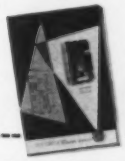
I-T-E magnetic trip Type ETI circuit breakers provide readily accessible trip adjustment.

FOR MOTOR APPLICATIONS... ETI BREAKERS INSURE BETTER PROTECTION

Type ETI magnetic trip circuit breakers employ specially designed overload devices to provide pinpoint, instantaneous short-circuit protection. When used in conjunction with motor protective relays, Type ETI molded case circuit breakers represent the ultimate in motor protection.

A new, informative booklet—yours for the asking—explains in detail why Type ETI molded case circuit breakers insure better protection.

As manufacturers of all types of circuit breakers—and the manufacturers of industry's most complete line of molded case breakers—I-T-E offers this booklet as a service to the electrical industry. Small Air Circuit Breaker Division, 19th & Hamilton Sts., Phila. 30, Pa.



WRITE TODAY FOR THIS NEW BOOKLET

Please send me your new booklet "TYPE ETI MOLDED CASE CIRCUIT BREAKERS FOR MOTOR CIRCUITS"

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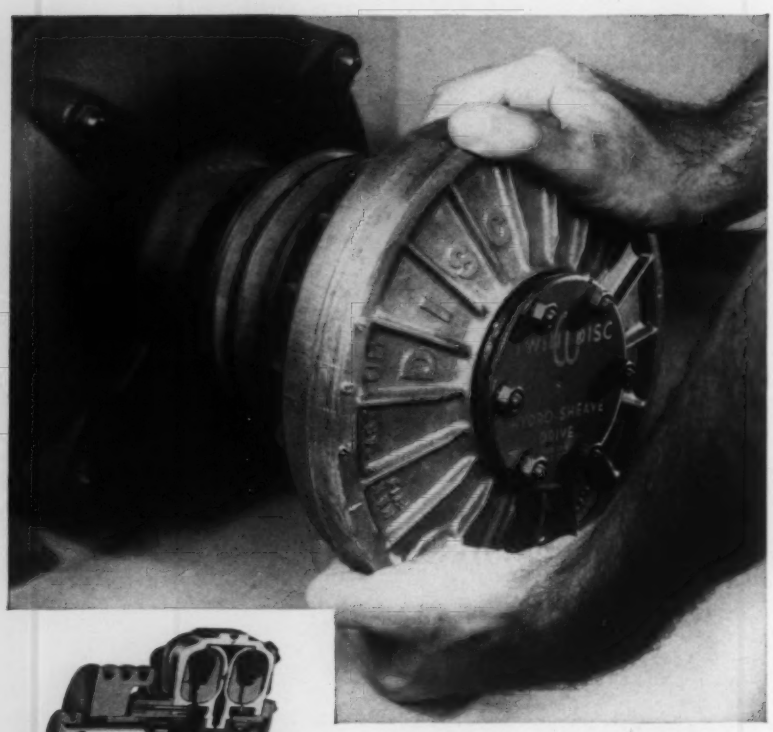

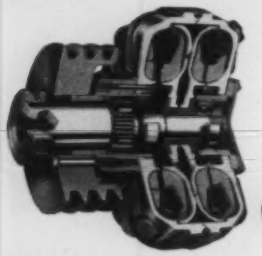

Convert to FLUID drive in only 5 MINUTES!

Fluid drive in a package . . . complete, ready-to-install . . . slips right over the motor shaft, easily in a matter of minutes. That's the Twin Disc HYDRO-SHEAVE® Drive—compiling new records for high production and low equipment maintenance.

Here's what the HYDRO-SHEAVE does

1. Reduces starting current demands . . . provides smooth, fast motor acceleration.
2. Protects against motor overloads, stalling and burn-outs.
3. Transmits full motor torque at all speeds.
4. Cushions out destructive vibrations and shocks, protecting both driving and driven equipment.
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Twin Disc Fluid Drives are available as HYDRO-SHEAVE Drives, from ¾ to 50 hp; Fluid Couplings from ¾ to 850 hp; and HYDRO-WYND® Drives, Models 8.4 and 12.2 for winding and tensioning.

Write today for full details on these profitable fluid drives. See how easily they will solve your power transmission problems. Request Bulletins 144-D and 145-C, from Dept. DS, Racine, Wisconsin.

TWIN DISC
Fluid Couplings

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

Branches or Sales Engineering Offices: Cleveland • Dallas • Detroit • Los Angeles • Newark • New Orleans • Tulsa

Fluid drives solve power transmission problems

To solve power transmission problems that *cut work output* and *raise costly downtime* on material handling equipment — more and more manufacturers *and* users specify various types of fluid drives.

Today, there are several types of these drives available, including fluid couplings, and single-stage or three-stage torque converters.

The fluid coupling is most widely used on equipment not requiring torque multiplication, but needing the shock cushioning characteristics of *fluid*.

The single-stage torque converter is found most frequently where power driven equipment needs only *mild* torque multiplication. Possibly a simple fluid coupling has been used in the past, so installation of a single-stage torque converter can "modernize" machinery without a complete redesign.

The three-stage torque converter —with multiplication up to 6:1—is usually found when it is desired to maintain nearly governed engine speed—with maximum power output over a wide range—and to produce high torque ratios for hoisting or heavily loaded vehicles.

Whatever the equipment, whatever the application, the Twin Disc Clutch Company offers the only *complete* line of industrial fluid drives available for dependably transmitting power to driven equipment. Fluid couplings are provided in a variety of models for engines and motors from ¾ to 850 hp . . . and torque converters, both single-stage *and* three-stage, are available for engines from 30 to 1000 hp.

If *you* have a power transmission problem, and if you feel that a fluid drive will help solve it, *consult* Twin Disc Specialists for unbiased recommendations as to which drive is best suited to your particular operation.

MACHINE DESIGN
March 6, 1958

An Index of Management Status

WALTER Reuther's plan to bargain collectively for profit sharing seems highly plausible at first glance. And the parallel proposal of a profit rebate to customers, pure grandstand play though it may be, will probably enlist some public support for the basic plan.

Profit sharing with employees isn't new, of course. But hitherto it has been initiated by owners and management. Unions have viewed it with suspicion. Traditionally labor has pushed for maximum security, leaving to owners the opportunity for profit as well as the risk of loss. Traditionally, too, distribution of corporate earnings has been decided by directors representing stockholders.

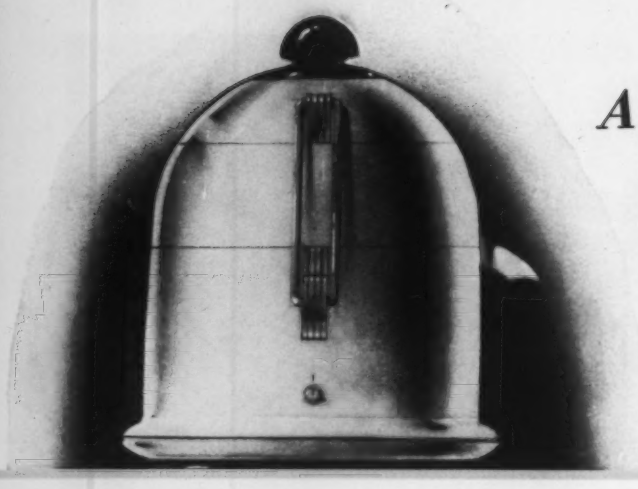
The controversy lends point to the differences between professional people and workers discussed by Ed Nevis elsewhere in this issue. Thus, where unions stress seniority, engineers emphasize merit. More than security, engineers seek the challenge of opportunity. Rather than an hourly wage plus overtime, engineers prefer a management-like arrangement that includes salary and bonus.

Mr. Reuther's thinking may be well ahead of that of the workers he represents. The bird-in-the-hand-worth-two-in-the-bush concept is strong in this security-conscious age. Even some engineers would probably hesitate to accept, in lieu of a salary increase, a share in corporate profit which, through circumstances beyond their control, may never materialize.

But if any group of employees should participate in profit sharing, it is the engineers. Often seeming to be in an ambiguous position between management and labor, engineers need closer identification with management. Such identification could go a long way toward keeping the more ambitious engineers from straying out of the technical field. And profit sharing is one index of management status.

Colin Carmichael

EDITOR



A guide to TECHNICAL

By **HANS PETER NELSON***, Assistant Professor
College of Engineering, Wayne State University
Detroit, Mich.

PICTORIAL drawings are valuable for depicting complex objects because shape and relationships between surfaces or parts can be readily comprehended by nontechnical personnel. These technical illustrations tend to speed up production, encourage accuracy, and cut the instruction time of workmen in addition to their value for use by sales, purchasing, stockroom, etc. Generally, engineers use one of the axonometric methods such as isometric, dimetric, trimetric, or oblique. Industrial designers usually employ the perspective method to show a proposed product because it gives a more accurate and natural appearance.

Many engineers fail to use freehand sketching as an aid to better visualization, perhaps because they feel that talent is necessary. While helpful, talent is not needed; anyone can learn to draw. For the engineer who works with nontechnical people, illustration staffs, publication assignments, or who likes to visualize the appearance of an object, an understanding of the artist's method of freehand drawing, the construction of axonometrics, obliques, and perspectives, and an appreciation of the effects provided by the various rendering techniques, will be very helpful.

*Also, consultant industrial designer.

▶ Drawing Methods

In preparation of a mechanical illustration, an important consideration is the angle from which the object is to be seen. The side which has the

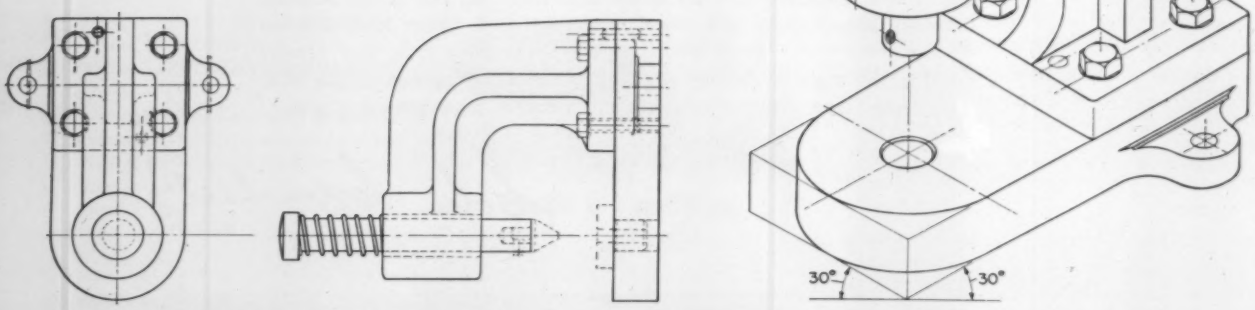


Fig. 1 — Comparison of orthographic and isometric projections illustrates ease with which the form of an object is conveyed by the pictorial treatment

ILLUSTRATION

. . . drawing methods and rendering techniques

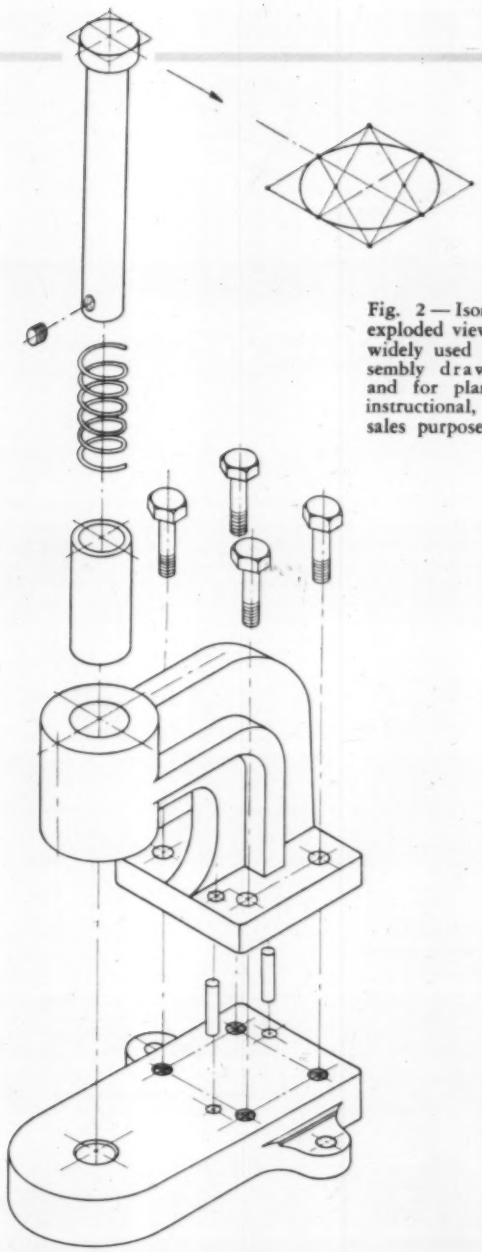


Fig. 2 — Isometric exploded views are widely used in assembly drawings and for planning, instructional, and sales purposes

most significant or complex features should be viewed along the longest line. Preliminary thumbnail sketches assist in organizing the drawing and selecting the best size and view. For purposes of clarity, the scale should be as large as possible and yet fit well on the required sheet size. Graphical representations, however, are not always made to the actual final size. By making an illustration two or three times the final size, errors will be minimized and lines, as reproduced, will be sharp and clean-cut. The drawing can then be photographed or photostated down to the desired size.

Extreme care must be taken with each individual line on the pencil drawing. If the line weights are not uniform nor dark enough, the illustration will appear weak and faded on the print. When the original drawing is well executed, all lines on the print will be well defined and any number of reproductions can be made from the tracing, each as good as the first.

Isometric Drawings: Of the axonometric pictorials, the isometric, Fig. 1, is most commonly used. Measurements of an object in an isometric drawing are taken directly from the orthographic projection, using convenient scales. To represent circles in isometric form, the four-centered approximate method is frequently used, Fig. 2. Also, there are various ellipse guides on the market which are of great help.

An exploded view shows all the individual parts in disassembled form to give the relationship of the parts or the order of assembly, Fig. 2. Instructional booklets that illustrate steps in taking apart a mechanical device, its repair, and its reassembly are a common use for isometric exploded drawings.

In isometric projection, all three faces of the object are foreshortened equally; in dimetric, two faces are equally foreshortened; and in trimetric

Fig. 3—Dimetric projections provide a realistic appearance; irregular outlines must be developed but templates are available for circles

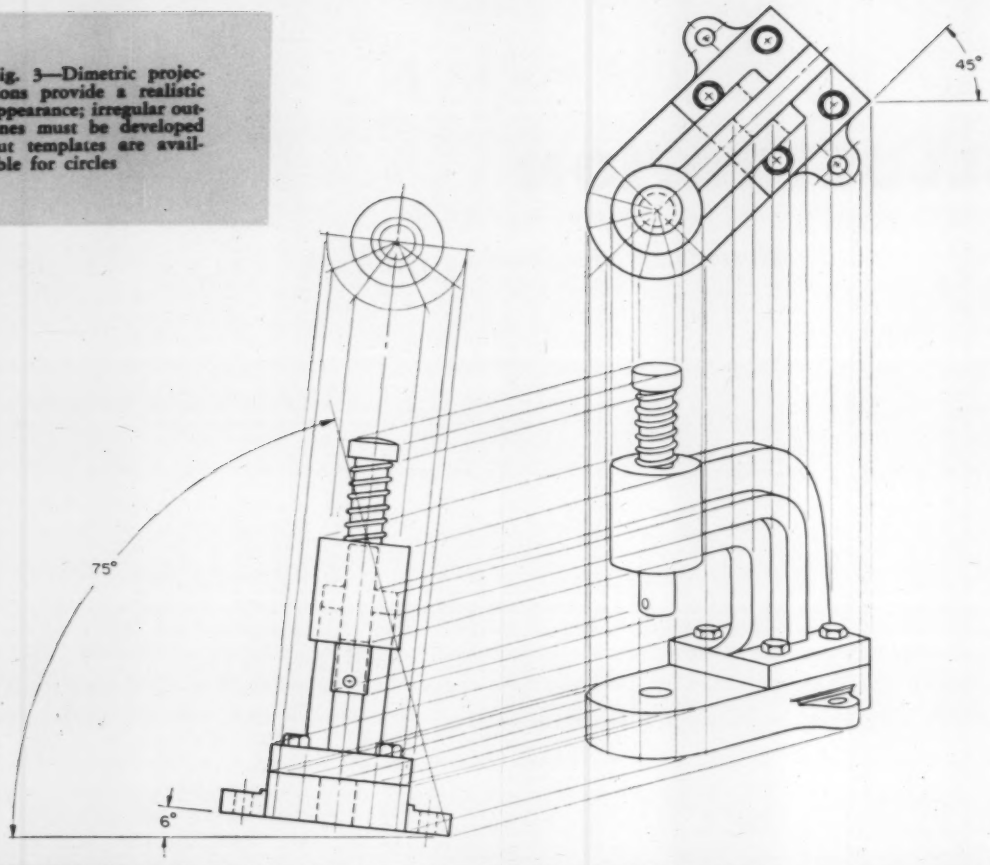
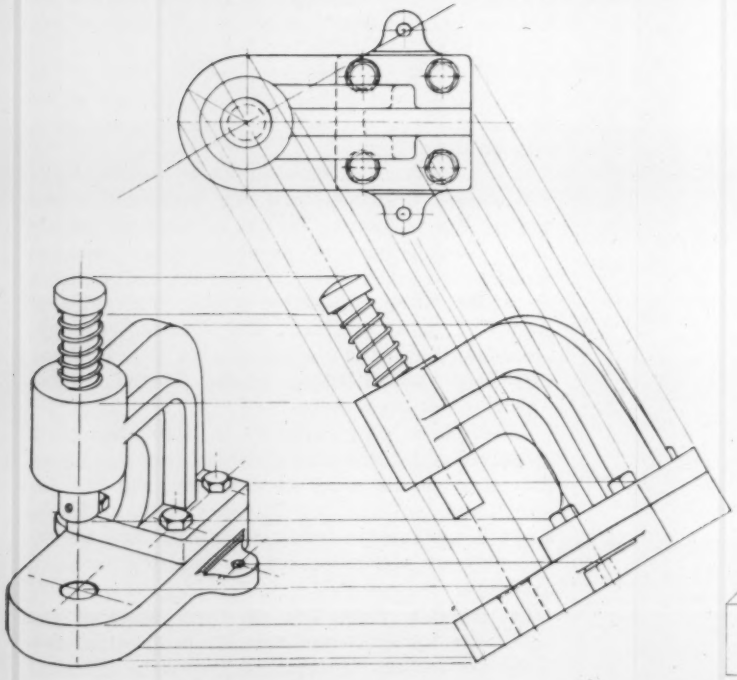
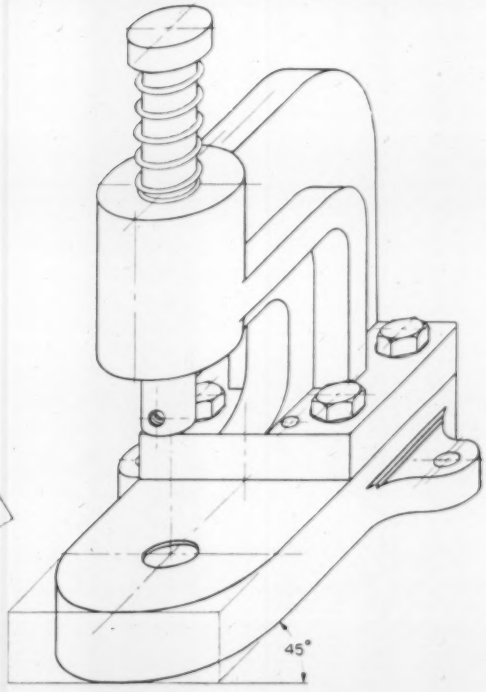


Fig. 4 — Trimetric projections are little-used due to the time consumed by their preparation

Fig. 5—Oblique drawings are fast and easy to make because the front face is based upon an orthographic construction. The receding axis is usually foreshortened; in this case a scale of ¾:1 was used





all faces are foreshortened unequally. Dimetric, Fig. 3, although pleasing in appearance, is less used due to the difficulty of drawing circles or irregular profiles, although circle templates are available. Trimetric projection, Fig. 4, is even less used because of the time consumed by the method.

Oblique Drawings: Another type of pictorial view is the oblique, Fig. 5, having the forward face of an object parallel to the frontal plane of projection, identical to an orthographic view. When there is more than one front plane, a particular plane is selected as constant and necessary measurements made from it. The receding axis is usually made to an angle of 45 deg and the depth dimensions are made along it. If the appearance can be improved, the receding axis should be drawn to a reduced scale. Measurements are taken from the orthographic views and transferred to the oblique to form the final picture.

Perspective Drawings: Superior to other kinds of pictorials since it approximates the results procured by the eye, perspective drawing uses projectors that are not parallel as in isometric or oblique, but that converge at a vanishing point.

In the perspective-plan method, Fig. 6, the plan view is placed near the top of the sheet, and a station point, which is the theoretical position of the eye from the top view, is chosen at a desired distance below the plan. The station point should be situated so that the object will be somewhat near the picture's center of interest. In this way, there should be no distortion.

With reference to the plan view, the picture plane is chosen as a horizontal line and usually runs through the lowest point, although it may cut through the plan at any desired place. The plan may be placed at any desired angle with the picture plane, determined by area and features of the two vertical surfaces.

Two lines are drawn from the station point, each one parallel to one of the vertical surfaces of the object as shown in the plan view. The points where these lines meet the picture plane are called vanish-

Fig. 6—Perspective views, although somewhat time-consuming, duplicate the appearance of an object as seen by an observer

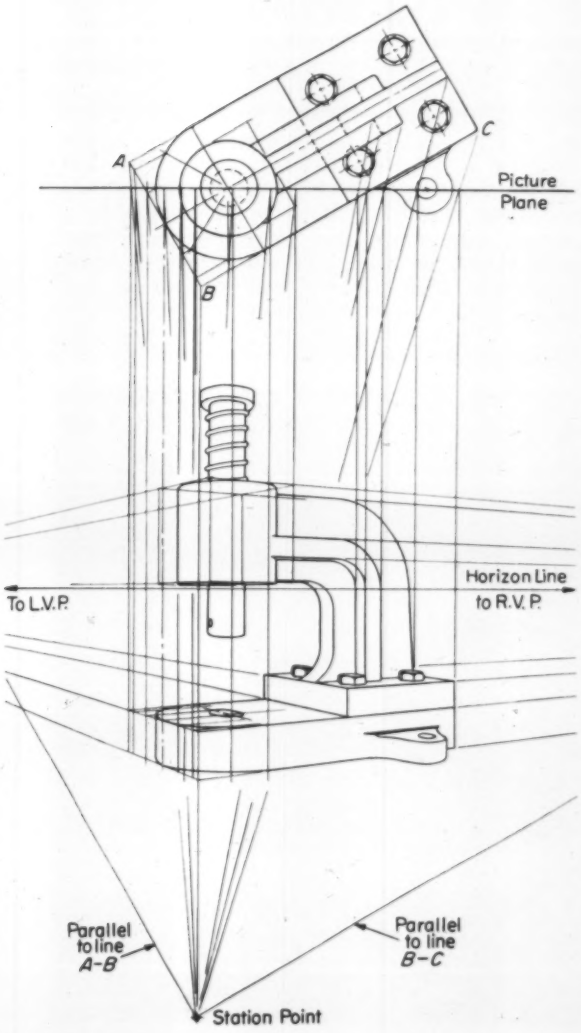
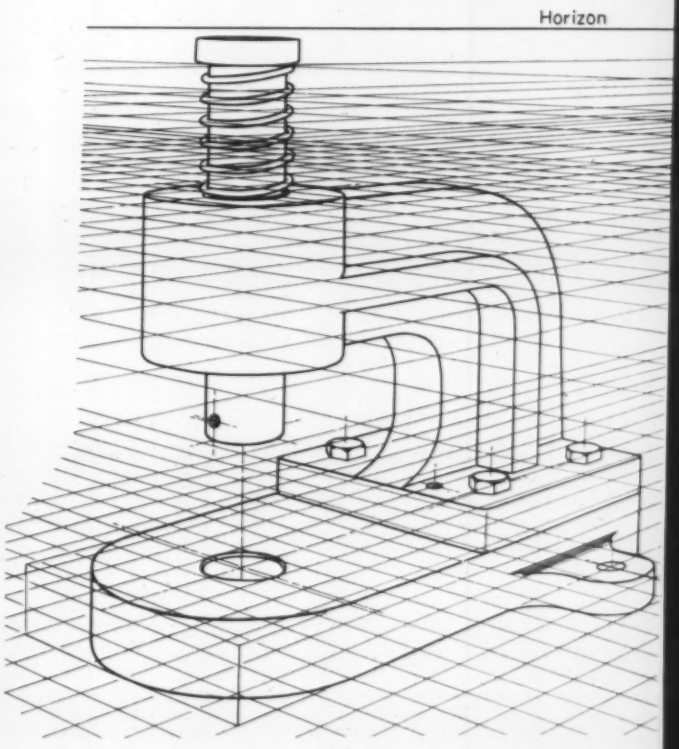


Fig. 7—Use of a perspective-grid underlay greatly speeds drawing of complex subjects



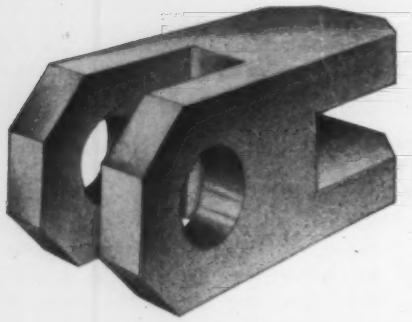


Fig. 8—Pencil shading is fast, simple, and extremely effective

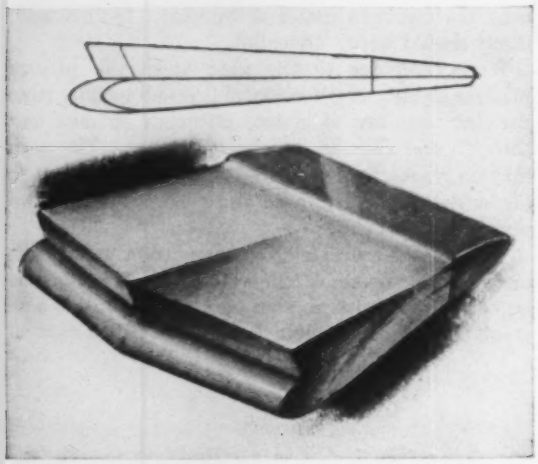


Fig. 9—Above—Pastel color sticks provide broad-area rendering in color, and are not difficult to apply

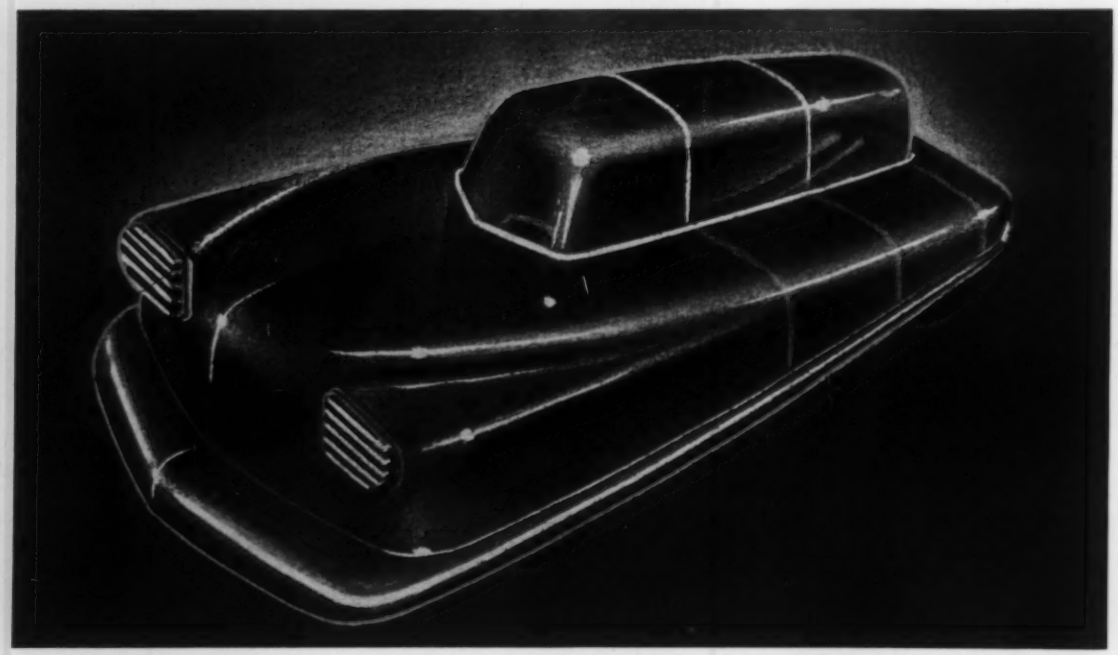
Fig. 10—Below—Pastel pencils are used to provide fine features, lines, and delicate shading

ing points in the plan view. These two points are then dropped vertically to the horizon, where they are used when making the perspective. The ground plane is chosen at a convenient location. True-size heights are spaced off on the measuring line which coincides with the picture plane; this is the only line on the perspective where true measurements can be made. The height points are connected to the left and right vanishing points to give the surfaces in perspective. Lines are then drawn from the station point to the corner points of the plan view and vertical lines dropped where the lines cross the picture plane. These lines determine vertical extremities of the object in the perspective view.

▶ Rendering Methods

The principles of illustration and most of the rendering methods are based on the pencil shading system used by artists. This system is quick, exceptionally effective, and gives good reproductions. If lighting conditions that actually exist are duplicated by shading on the drawing, a realistic effect is produced. Study of the principles of shades and shadows is important since the result is a complete and comprehensive effect of realism.

A shaded drawing is used to simplify shapes that are not indicated by the outline alone. In attempting to convey the likeness of a sphere by making its outline, the effect of roundness is lost; giving the circle a flat tone is equally inadequate. The desired effect is achieved only by copying the gradations of shadow found on the surface as a result of light and shade. To represent a cylinder or a sphere as solid and round, graded tones (gradations from black to white) give the best result.



Drawing Pencil: Very often, jobs must be completed in quick order. In comparison to other methods such as the airbrush, pencil shading can be of great value for fast work. The pencil may be sharpened on a bevel to give a broad stroke, or conically to give sharp line definitions and graded tones. Pencil strokes should be definite and clean-cut, with the dark tones very dark to give accentuation to the lighter surfaces. This is best brought out when tones are graded across an area, rather than uniform throughout, Fig. 8.

Pastel Stick and Pencil: Pastel rendering is a very effective method of obtaining realism in the shape and color of an object. It is well known for its excellent and varied results in the architectural and industrial design fields, but little used in the technical illustration and engineering professions. Since pastel work is comparatively new, most mechanical illustrators have not had the opportunity of exploring this medium. Pastel color sticks (Nupastel) provide broad-area rendering by rubbing, Fig. 9. Pastel pencils (Kartothello) are best used to delineate small or difficult places on the drawing, Fig. 10. The stick and pencil, each a pastel product, yield quick and spectacular results. Should it be necessary to change the color or tone, the pastel can be erased without harming the paper, and new tones can be applied and blended in to make a good finished job.

Pastel can be used on tracing paper by pressing the stick or pencil on the area to be toned. The area is then rubbed with the finger to smooth out the tone or to achieve gradations. If a Strathmore paper is used, the pastel can be ground into a powder with a knife or sand-paper pad and then rubbed into the paper with a chamois skin or piece of cotton.

Drawing Ink: Since ink-line shading reproduces well, it is widely used as common practice. To use this rendering method, one must learn to combine lines to form tones, remembering that exact portrayal of values is not expected. Straight lines of graduated widths may be used on cylindrical surfaces, with white spaces for the highlight and reflected-light areas. With curved and spherical surfaces, line elements may be drawn with varying spaces. When shading any of these surfaces, the illustrator should choose the direction of light source and then generally estimate the shading.

Stipple: This rendering method consists of producing a multiplicity of black dots with a pen or brush; the dots vary in size and spacing depending on the shading desired. It is not too difficult but it is rather slow. However, continuous, careful stippling will give an ultimate result that is satisfying and well defined, Fig. 11*a*.

Prepared Shading Materials: The Ben Day or Zip-A-Tone overlays consist of lines or dots, printed on a transparent sheet of cellophane with adhesive on the reverse side. There are a wide variety of

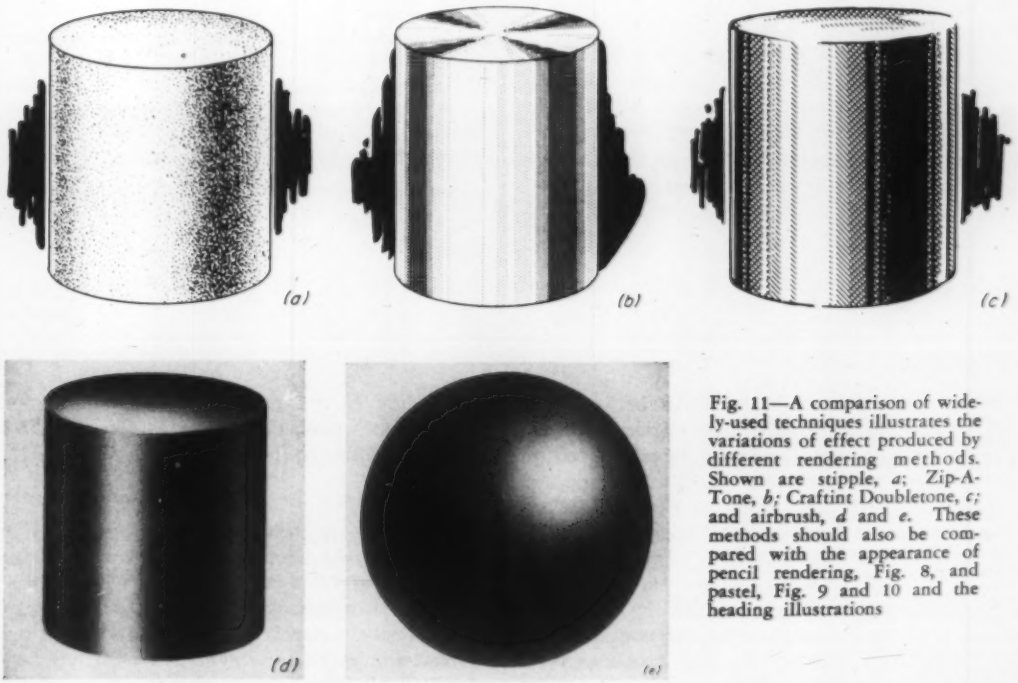


Fig. 11—A comparison of widely-used techniques illustrates the variations of effect produced by different rendering methods. Shown are stipple, *a*; Zip-A-Tone, *b*; Craftint Doubletone, *c*; and airbrush, *d* and *e*. These methods should also be compared with the appearance of pencil rendering, Fig. 8, and pastel, Fig. 9 and 10 and the heading illustrations

designs to choose from, either black or white, and with dots and distances available in wide variations. The overlay is placed over the part of the drawing to be shaded, pressed down with the fingers or a triangle, and a frisket knife is used to cut off the excess overlay. This system, Fig. 11*b*, lends itself very well to reproduction.

The Craftint Co. sells a chemically treated tracing paper and board called Craftint Doubletone which will give a four-tone drawing. One developer, when applied to the treated paper with a brush or ruling pen, brings out black diagonal lines. Another brings out two sets of crossing diagonal lines which give a darker effect. Regular drafting ink and the white of the paper or white water color is usually added to these light to medium tones, Fig. 11*c*. Shading experience is valuable since good judgment is necessary to secure adequate shading from only four tones.

Airbrush: To make a drawing with the appearance of the actual object, Fig. 11*d*, the airbrush is most frequently employed. The airbrush sprays water color on a drawing by means of compressed air from a tank or compressor. The brush has an adjustment on its needle to give a fine or a coarse spray, or to give a wide beam of color. Shielding is necessary to confine the spray to the desired areas. The simplest method of protecting a drawing during shading is to cover the entire drawing with a thin transparent paper, the underside of which has been coated with rubber cement. This coated paper, known as a frisket, may be purchased or prepared by spreading two coats of rubber cement over the entire surface (the first coat is allowed to dry thoroughly before the second is added). The frisket will adhere well to the drawing and there will be no tendency for the water color to blow under the edges. A stencil or template can also be used for airbrush work. The template is a sheet of tracing paper that has the exact areas cut out where the tone on the drawing is to be made. Small weights must be placed at the edges of the aperture to hold the template firmly to the drawing. Normally, the frisket can be used to better advantage than the template.

Photography: An additional use for the airbrush is for retouching photographs. New highlights, shades, and shadows can be made on the photograph where the representation is dark or undefined. A great many of the mechanical illustrations that are found in work-specification manuals and training handbooks are made by photo retouching.

A very effective exploded view can be made by mounting individual parts, in their proper order, on a peg board and making a photograph. The peg board is then masked or retouched out of the photograph, leaving a very good exploded view.

It is necessary to select the method of procedure —a new illustration or a retouched photograph. Usually the method chosen is the one that is the most economical and still will give the desired result. Clarity and definition of mechanical form are always essential in industrial technical illustrations.

Additional Reading

Technical illustrating has been the subject of numerous articles in MACHINE DESIGN. Two very useful perspective techniques were covered in the following issues:

"Perspective Drawing" ..... November, 1955
"Large Perspectives Simplified" ..... December 13, 1956

Drafting techniques based upon use of intermediate reproductions offer great potential for use in technical illustration and were covered in:

"How to Save Drafting Time" ..... January 26, 1956

An interesting method that has great merit is based upon photographing models of large or nonexistent objects, as in a proposed design. While the models will normally not contain all the details of a complex object, these can be added by retouching the photo or using the photo as a base for a drawing. Construction of these models was given in:

"Cardboard Mock-ups and Models ..... October 4, 1956

Of considerable interest to designers are the legal implications of their work. These were well delineated in two articles by Albert Woodruff Gray:

"Design Patents" ..... January 12, 1956
"Protecting Design Ideas" ..... March 8, 1956

They Say . . .

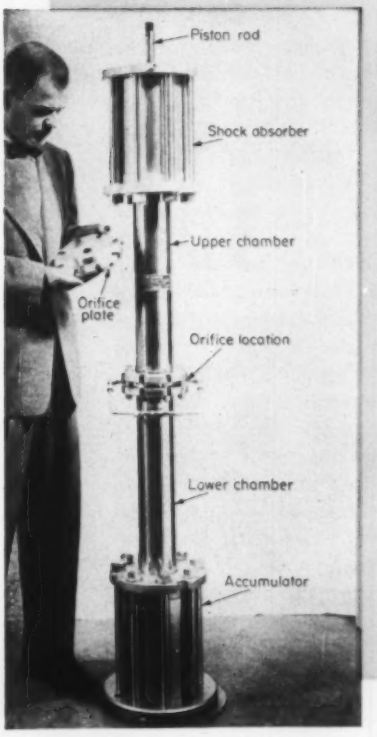
"This problem of communications between the managers and the specialists in an organization engaged in development work can be alleviated to some extent by the paraphernalia of administration —regular and irregular channels for flow of information, design review committees, staff meetings—but the key to the solution is mutual understanding between the managers and the specialists. The managers should be prepared by education and experience to understand the specialists. The specialists should separate the key problems from the mass of unimportant detail and should present their recommendations so precisely and clearly that they cannot be misunderstood."—MORROUGH P. O'BRIEN, *dean, College of Engineering, University of California, Berkeley, Calif.*

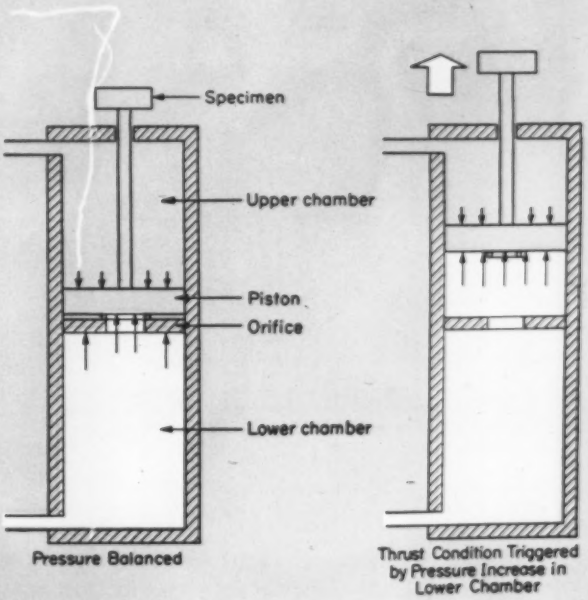
"We have achieved enormous increases in the productivity of shop-floor labor by deskilling the work of craftsmen and by the use of machines; and by proper organization of work, output has risen enormously. Surely it is equally important to effect comparable economies among professional engineers."—SIR GEORGE H. NELSON, *president, Institute of Electrical Engineers.*

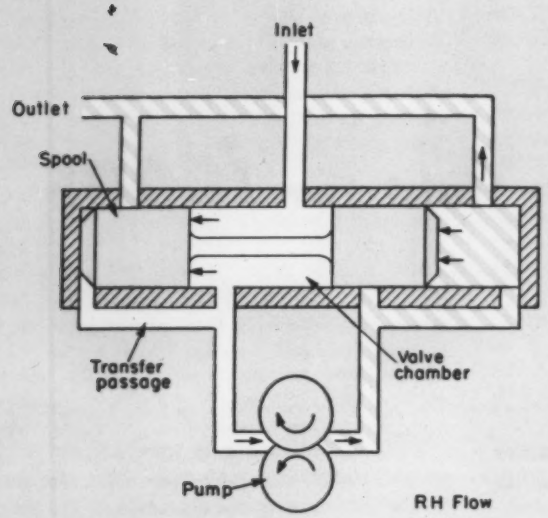
scanning the field for *ideas*

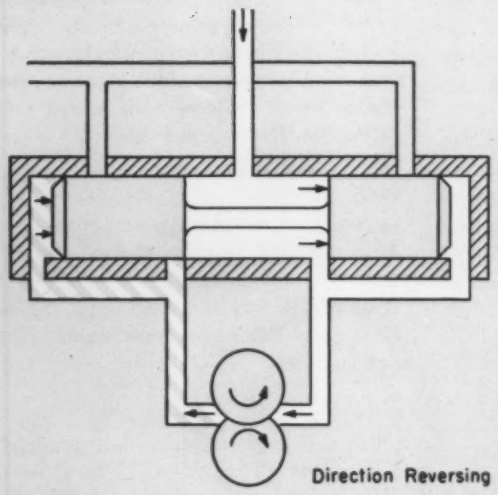
Controlled, high energy release is obtained by instantaneously changing the effective piston area in a dual-chamber hydraulic-cylinder design. For the Hyge shock tester, predetermined shock loads are achieved by altering the balance of pressure of opposite sides of the cylinder piston. The two chambers are connected by an orifice plate; the piston is in the upper chamber and is connected to a column which acts against the test specimen. The upper chamber is pressurized to a low degree, forcing the piston down against the orifice plate where a seal ring on the face of the piston reduces the effective area exposed to the lower chamber.

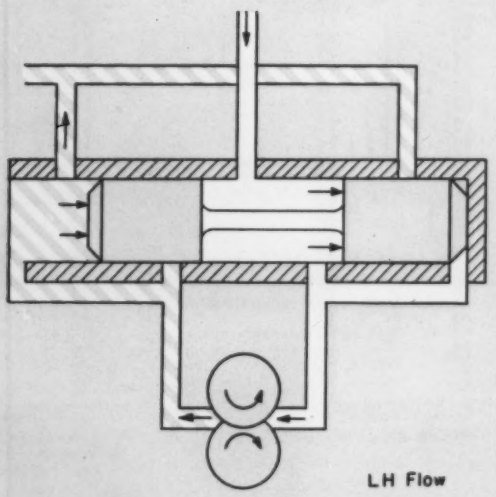
The lower chamber is then pressurized to an extremely high value, so that the force on the bottom, reduced-area face of the piston is in balance with the force on the upper, low-pressure face which is completely exposed. When the pressure in the lower chamber is increased above the balanced condition, the piston is forced away from the orifice plate, the seal ring at the orifice becomes ineffective, and the full area of the bottom piston face is exposed to high pressure. Acceleration of the piston is instantaneous, providing extreme thrust to a specimen mounted on the piston rod. The design was developed by the Convair Div. of General Dynamics Corp. and licensed to Rochester Div. of Consolidated Electrodynamics Corp.

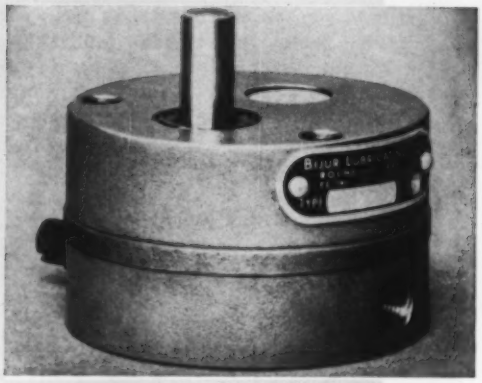








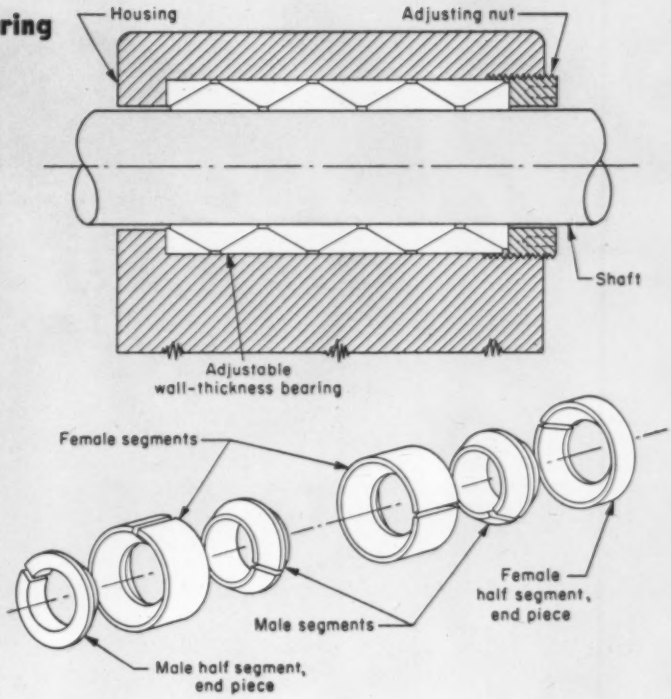




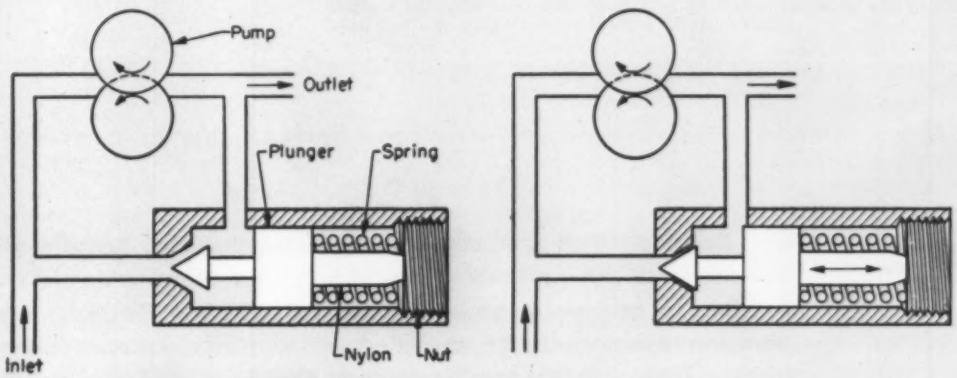
Automatic transfer valve in hydraulic gear pump provides unidirectional flow, regardless of direction of input rotation to gears. The transfer valve is located in the inlet line and consists of a simple movable spool in a valve chamber. At each end of the chamber is a transfer passage connecting the center of the valve chamber, the pump gears, and one end of the spool, and leading to the pump outlet. During operation, the spool is at one end of the valve chamber. It is maintained in this position by suction pressure applied against one of the internal faces as the oil is drawn to the pump and by output pressure against the end of the spool as oil is pumped to the outlet.

On reversal of drive direction, the oil in the tooth spaces of the meshing gear rotors is forced into the valve chamber and the transfer passage to the spool end. The spool moves to the opposite end of the chamber, closing the previously used outlet passage and opening the one on the opposite side.

Adjustable-diameter bearing with telescoping conical elements permits variation of outside and inside diameters to meet assembly and operating requirements. Developed and patented by Kenneth H. Pitzer, Los Angeles, Calif., the bearing consists of alternate male and female segments aligned axially to obtain the desired length, and terminating with half segments at each end. Under axial force, the segments expand and contract to vary the effective ID and OD of the bearing assembly. When confined within a housing with provision for applying axial pressure to the bearing, the design permits wide production tolerances on shaft and bore, easy installation, adjustment of fit between bearing and shaft, and simple compensation for wear.

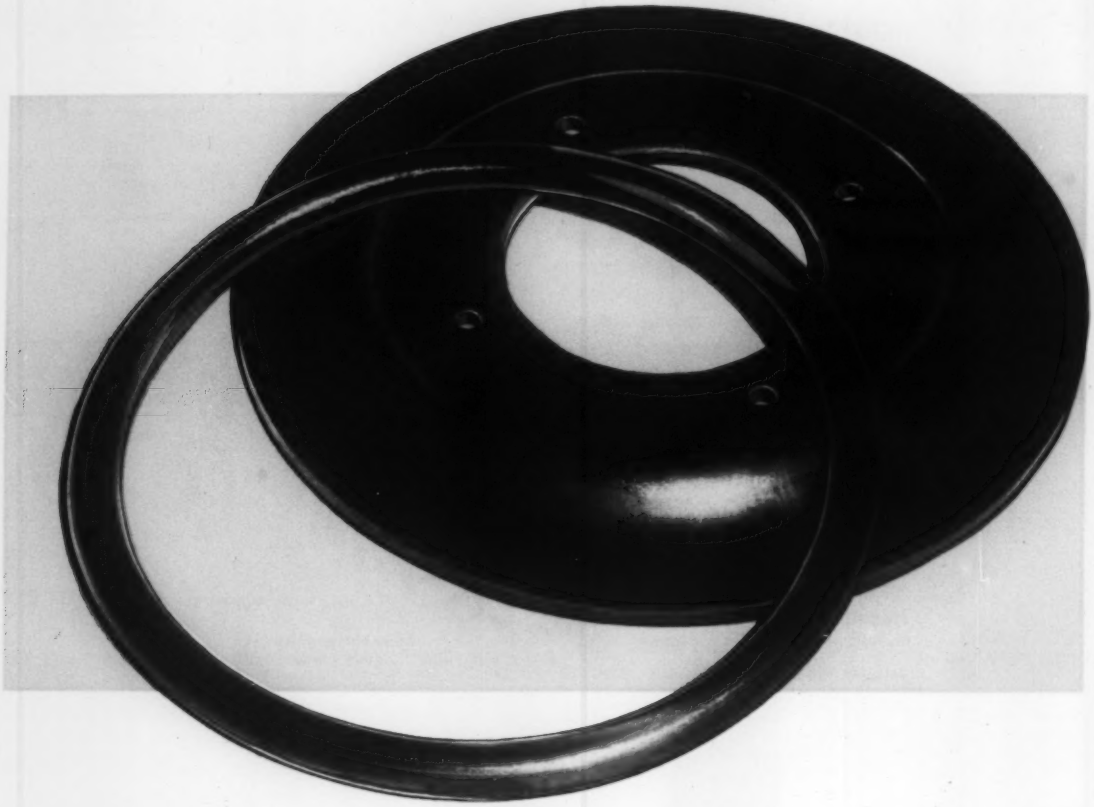


Automatic compensation for viscosity changes is provided in a constant-pressure pump by a nylon spacer that expands or contracts in a valve opening to maintain a uniform flow rate under varying temperature conditions. In a gear pump developed by Cummins Engine Co. Inc., the nylon spacer fits behind the spring-loaded plunger of a bypass valve that establishes output pressure of the pump. The plunger is set by an adjusting screw; the nylon spacer is located between the needle and the screw. Under low-temperature, heavy-viscosity conditions, the spacer is contracted and the valve is at maximum opening. As the liquid being pumped warms up, the spacer expands, reducing the valve opening and maintaining the established pressure setting.



Low Temperature, Maximum Opening

High Temperature, Minimum Opening



Properties and applications of

Urethane Rubber

Relatively new synthetic elastomers, the urethane rubbers, can be tailored to exhibit combinations of properties which are often impossible to achieve in other rubbers. For example, hardness and abrasion resistance can be combined with elasticity in certain formulations. These unusual combinations of properties, and applications prompted by them, are discussed in this article.

- **Load-carrying capacities**
- **Friction characteristics**
- **General properties**
- **Applications**
- **Hardness and elasticity**
- **Abrasion resistance**
- **Oil resistance**
- **Low coefficient of friction**
- **Miscellaneous uses**

Fig. 1—Urethane rubber tank car dome gasket and flexible diaphragm. Both have excellent resistance to rubber solvents and ozone, and extremely high flex life. In most applications, minimum thicknesses must be specified when designing diaphragms of urethane because of its high hysteresis factor.

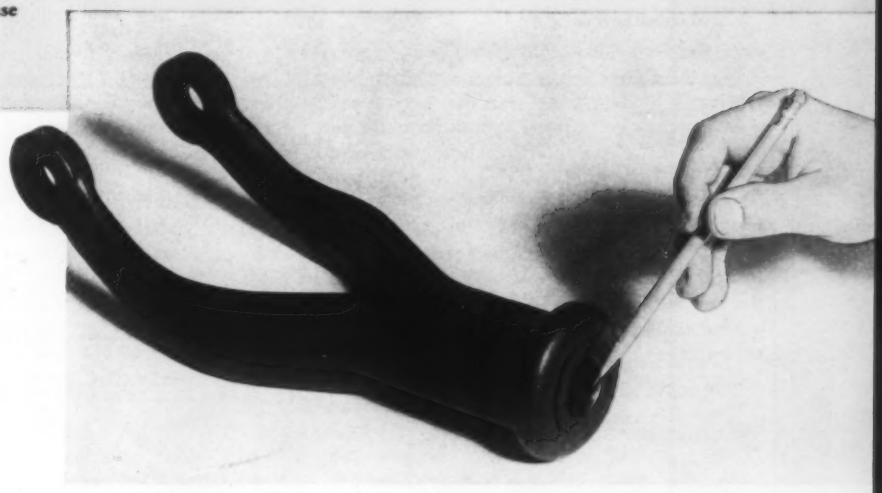


Fig. 2—Air-hammer fork bracket of urethane rubber with steel insert. Part requires a material with good shock absorbent qualities and high hardness to withstand full operating pressure exerted on the hammer.

By R. H. KITTNER
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Mobay Chemical Co.
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URETHANE rubber is a tough, synthetic elastomer which has properties commonly associated with the term "rubber." In terms of functional properties, however, urethane rubber is quite different from conventional rubber materials because its molecular structure can be arranged to combine certain desirable properties in the end product. In contrast, compounding or additives are generally required to modify the basic properties of other rubber materials.

Urethane rubber has excellent elongation, high tensile and tear strengths, and high resistance to abrasion and oxidation. Soft grades of these elastomers may be produced with extremely high strength but with the added feature of high abrasion resistance. Harder grades provide a structural and engineering material which combines high hardness and elasticity with other desirable properties.

All rubber materials have the same basic properties but in varying degrees. However, it is the ability to combine certain properties, such as toughness and resilience at high hardness, that distinguishes urethane rubber. With urethanes it is not necessary to choose between hardness and elasticity. Urethane rubber can be made extremely hard and abrasion resistant without relinquishing elasticity, resilience, or shock absorbing properties. Its hardness ranges from 60 to 95 Shore durometer, A scale, but tensile strength remains

Table 1—Properties of Urethane Rubber

Properties	Vulkollan 18/40	Vulkollan 18	Vulkollan 25	Vulkollan 30
Mechanical				
Tensile strength, psi	4000 to 5000	5500 to 7000	4500 to 6500	4500 to 5500
Elongation at break, per cent	550 to 650	600 to 800	600 to 700	450 to 500
Modulus,* psi, at				
100 per cent elongation	250 to 300	475 to 550	1000 to 1100	1200 to 1400
200 per cent elongation	450 to 500	650 to 750	1400 to 1500	1700 to 2000
300 per cent elongation	700 to 800	1200 to 1500	2200 to 2500	2700 to 3000
Elongation set, per cent	5 to 10	3 to 10	20 to 30	35 to 45
Tear strength, lb/in.	280 to 320	450 to 525	550 to 600	550 to 700
Hardness, Shore durometer, A scale	60 to 65	78 to 83	88 to 92	93 to 96
Elasticity, per cent	45 to 50	50 to 60	50 to 55	45 to 50
Thermal				
Thermal conductivity,				
kcal/m/hr/deg C	0.200	0.200	.....	0.205
Btu/sq ft/hr/in./deg F	1.6	1.6	.....	1.6
Linear coefficient of expansion,				
0.000001-in./deg C	145	200	.....	174
Specific heat, cal/gm/deg C	0.46	0.44	.....	0.42
Electrical				
Breakdown voltage, v/mil	530	450	.....	525
Surface resistance, ohms	4×10^{10}	5×10^{10}	.....	1×10^{11}
Volume resistance, ohms	9×10^{10}	2×10^{11}	.....	3×10^{11}
Volume resistivity, ohm-cm	2×10^{11}	5×10^{10}	.....	3×10^{11}
Dielectric constant,				
800 cycles	7.5	7.6	.....	6.7
10,000,000 cycles	7.1	7.1	.....	6.4
Physical and Chemical				
Specific gravity	1.24	1.24 to 1.25	1.25 to 1.26	1.24 to 1.26
Solvent resistance, per cent swelling				
Water	.....	1.5	.....	1.5
Ether	.....	10	.....	8
Alcohol	.....	15	.....	8
Toluene	.....	37	.....	25
Carbon tetrachloride	.....	44	.....	33
Benzene	.....	60	.....	36
Methylene chloride	.....	310	.....	165
Acid, dilute and concentrated	.....	Destroyed	.....	Destroyed
Alkali, dilute and concentrated	.....	Destroyed	.....	Destroyed

*Stress at elongation shown.

between 5500 and 7000 psi and elongation from 600 to 800 per cent. In contrast, GR-S rubber of 60 to 65 durometer hardness has a tensile strength of 3800 psi and 550 per cent elongation. In addition, urethane rubber shows excellent resistance to standard rubber solvents and complete resistance to ozone, Fig. 1.

One of the more significant characteristics of urethane rubber is that tear strength and abrasion resistance increase in almost direct proportion to hardness. A urethane rubber with a hardness value of 78 to 83 durometer, A scale, exhibits extremely high wear resistance.

Load-Carrying Capacity: In rubber compounding, materials such as waxes, plasticizers, fillers,

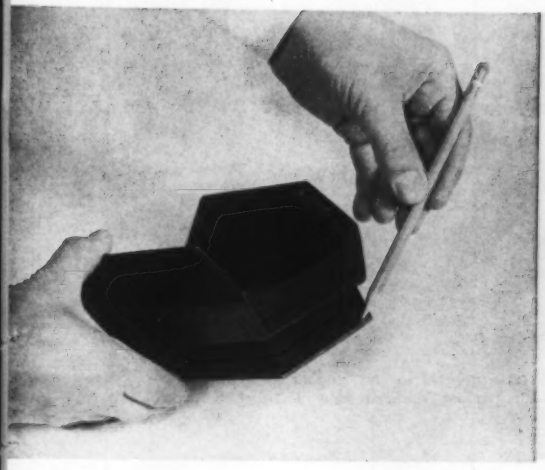


Fig. 3—Automotive spring slide block with steel attachment plate. Combination of a soft urethane rubber and a hard self-lubricating grade provides high wear resistance and long life in parts for bearing applications.

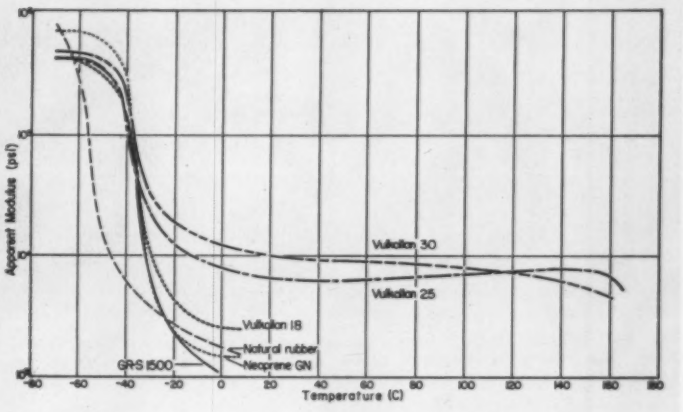


Fig. 4—High and low-temperature properties of three types of urethane rubber compared to conventional rubber. Urethane rubbers stiffen at low temperatures but do not become brittle until about −94 F.

and reinforcing agents are usually blended into the rubber to modify basic characteristics of the material. In urethane rubber, the molecular structure of the material itself is modified, which imparts uniformity to the end product and makes precise quality control possible.

Cast urethane rubber items can be produced with a hardness of 80 to 95 durometer, A scale, without inert fillers or fabric lamination. These hard, high-load bearing rubbers still retain the elasticity and vibration-damping characteristics of unfilled natural or synthetic stocks in the 50 to 60 durometer range. Fig. 2 shows an air-hammer fork bracket as an example of a vibration-damping application.

Friction Characteristics: Normal urethane rubbers have a very high coefficient of friction and are useful for all types of friction-drive assemblies. It is usually necessary to redesign standard friction drives for urethane rubber, however, because little pressure is required between driving members to transmit power without slippage. This redesign also reduces heat buildup caused by constant flexing. Power drives from ½ to ⅓ the size of standard rubber drives with equivalent power transmission rating are possible with urethane rubber. By special compounding, however, urethane rubber can be made self-lubricating for bearing applications, Fig. 3.

General Properties: Another remarkable characteristic of urethane rubber is that tear strength increases with hardness, Table 1. Abrasion resistance also increases with hardness. In addition to its excellent long-term wear resistance, urethane rubber maintains a high degree of dimensional stability because it absorbs less than 1 per cent moisture.

High-temperature strength of all urethane rubber is good but "maximum use" temperature depends greatly on service conditions. Urethane rubber has good oxidation resistance and has been subjected to use tests continuously at 175 F, for a number of days at 212 to 230 F, for several hours at 266 F, and for a few minutes at 300 F with no signs of deterioration. In addition, one urethane rubber, Vulkollan 18, has been subjected to oil immersion at 266 F for 100 hr with no destruction of properties. Harder grades of urethane rubber retain their properties better at elevated temperatures than do the softer materials, but continuous use in contact with hot water or steam is not recommended.

At low temperatures, urethane rubbers stiffen but do not become brittle until about −94 F. Gradual stiffening takes place as temperature decreases but does not become pronounced until temperatures of −4 to −22 F are reached. In this property, urethane rubber is very similar to conventional synthetic rubbers. Fig. 4 shows high and low temperature properties of three types of urethane rubber.

When urethane rubbers are stretched and held in the elongated state at low temperatures, they may show a 100 per cent set but will recover original dimensions when warmed to 122 F. Of practical significance, however, is the fact that urethane rubber diaphragms are used successfully in outdoor temperatures of −4 F. The hysteresis characteristics of the material are such that a few flexes will provide enough heat energy to keep the unit soft enough for operation well below this temperature.

Mechanical properties of urethane rubbers may be modified somewhat by extenders such as fillers and plasticizers, but these additives are not normally recommended. Fillers, such as carbon black,

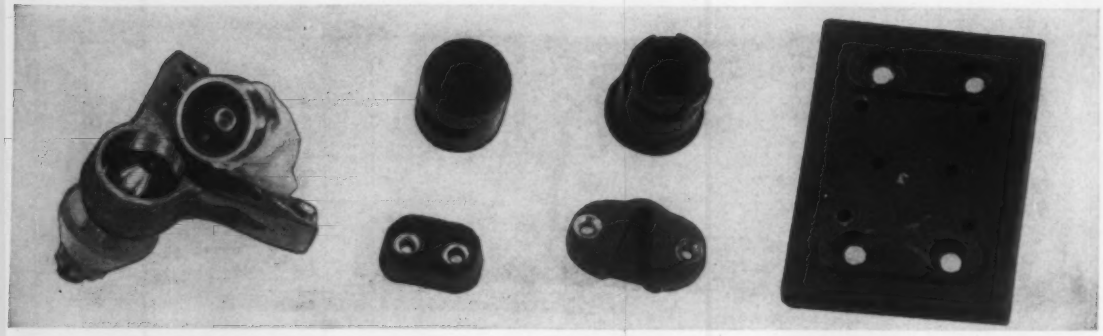


Fig. 5—Urethane rubber inserts pressed or molded into place. Castability of urethane rubber permits undercuts, slots, tapers, threads, integral inserts, and other complex design configurations to be molded into a finished piece.

do not reinforce urethane rubbers as they do hydrocarbon elastomers. However, they do increase modulus of elasticity and decrease elongation somewhat. Plasticizers soften urethane rubbers and reduce their properties generally, but impart improved low-temperature flexibility. Mechanical, thermal, electrical, and physical properties of various types of urethane rubber are shown in Table 1.

Applications: Thus far, uses for urethane rubbers have stemmed from their unusually high wear and oil resistance, and from the unique combination of hardness and elasticity which can be achieved in certain formulations. In many cases, these properties have permitted a sizable savings in fabricating costs. For example, urethane rubber is easily cast in simple and inexpensive molds to produce parts with difficult design features such as undercuts, slots, tapers, threads, and integral inserts, Fig. 5. In other cases, extension of service life has resulted in greatly reduced maintenance costs.

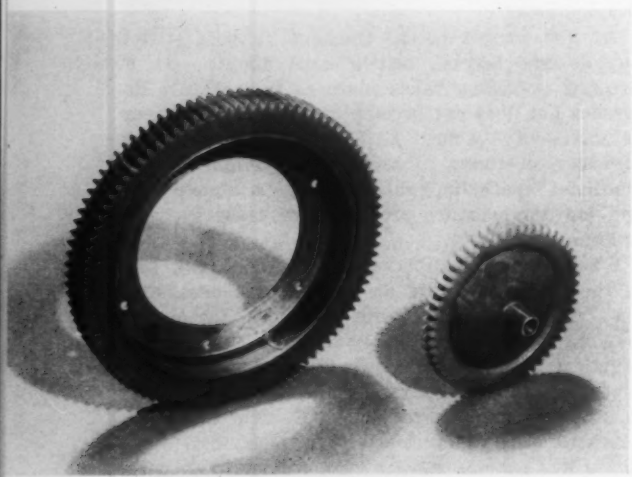


Fig. 6—Right—Mixer gear assembly with wear-resistant urethane rubber teeth cast over the T-section of a zinc hub. Left—Drive gear with urethane rim and teeth cast over a steel hub. Rim is locked in place by allowing urethane to flow through rivet holes during casting. In both applications, urethane rubber extends service life appreciably and is not affected by foreign material in the gear mesh.

These benefits can easily offset the relatively small differential in raw materials cost between urethane rubbers and conventional rubbers of the hydrocarbon and synthetic types.

To emphasize the way in which properties have prompted specific uses for urethane rubber, significant applications are listed in the following groups according to properties required.

Group 1—Hardness and Elasticity: A high-durometer urethane rubber, Vulkollan 30, combines high elasticity and appropriate hysteresis to provide excellent shock absorbing power and vibration-damping properties. This formulation is used as shock absorbent pads under machinery where vibration or impact shock is a problem. Constant-load limit is 1400 psi, but this material will satisfactorily withstand sudden shock loads of 2800 psi.

Urethane rubber gears will withstand a high degree of misalignment without damage or malfunction, and will resist high shock loads. Wide tolerances on dimensions are permitted in both the primary part of the gear, the urethane teeth, and its adjacent metal part, the hub, Fig. 6. Gear teeth are not affected by dirt particles in the mesh.

Other applications include suspension bearings on heavy earthmoving equipment and farm machinery; bottoming rings in automotive shock absorbing units; and similar heavy-duty uses in textile machinery. Flexible-coupling connector discs of this urethane rubber will support high loads, yet permit up to 0.040 in. linear and 12 degree angular misalignment without malfunction. Typical flexible-drive couplings of urethane rubber are shown in Fig. 7. Effect of temperature on hardness and rebound elasticity of two types of urethane rubber is shown in Fig. 8.

Group 2—Abrasion Resistance: Another formulation of urethane rubber combines excellent abrasion resistance, high tear strength, and a moderately high coefficient of friction. Industrial truck tires cast of a urethane rubber of 95 durometer, A scale, support heavy loads with minimum deformation under constant static or dynamic loading. Tests show that these solid wheels reduce power consumption of the equipment by as much

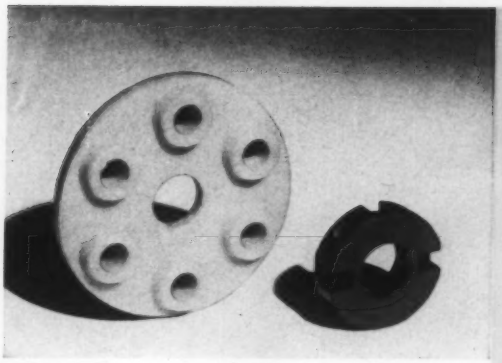
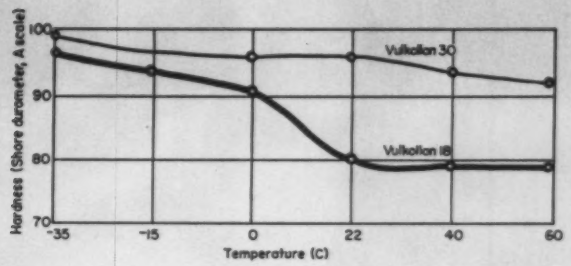


Fig. 7—Flexible-drive couplings of urethane rubber. Excellent abrasion resistance and moderately high coefficient of friction combine to make the couplings highly efficient. Angular and linear misalignments of 12 degrees and 0.040 in. respectively cause no malfunction.



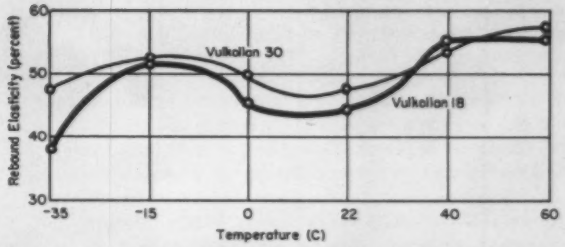


Fig. 8—Effect of temperature on hardness and rebound elasticity of two types of urethane rubber. Rebound elasticity is good in all urethane rubbers and ranges from 45 to 60 per cent. Vulkollan 30 shows an unusual combination of high hardness and rebound elasticity.

as 50 per cent because less energy is absorbed by tire flexing.

Friction wheels and drives of various descriptions are being manufactured from this material because of the low abrasion loss and low noise level, and high coefficient of friction. A typical power-transmission application in adjustable-speed drives, for example, makes use of a metal cone covered with a 0.2-in. layer of urethane rubber.

Because of low-temperature behavior and flex fatigue resistance, pump membranes are made of urethane rubber. In one application, 0.3-in. thick membranes required replacement after 50,000 flexing cycles. When thickness was reduced to 0.1 in., membranes were still performing satisfactorily after more than 1½ million cycles and had more than adequate functional properties. In flexing applications, it is desirable to specify urethane rubber sheets at close to the minimum permissible thickness because of the high hysteresis factor.

Group 3—Oil Resistance: Urethane rubbers are used as gasket materials in contact with various types of oils. However, it is recommended that tests be carried out beforehand if the application involves direct contact with oil. Most oils have little effect on urethane rubbers, but some types of oil additives may attack the material.

Vulkollan 30 is used for gaskets in oil emulsion hydraulic systems because of its low abrasion loss, good oil resistance, and low compression set. Urethane rubbers are not recommended for contact with oil and high-speed rotating axles, such as required for rotary seals, since the combination of oil and frictional heat tends to make the material sticky.

Urethane rubber cylinders with steel casings, measuring 16 in. long by 4 in. in diameter, are used as hydraulic mine supports. Oil is pumped in to extend the urethane diaphragm to twice its length at 9000 psi.

Group 4—Low Coefficient of Friction: All grades of urethane rubber can be modified with additives to make them self-lubricating. The additives give them a very low coefficient of friction and further improve their already high abrasion resistance. These self-lubricating types are excellent for oscillating and sliding motion, but thorough testing is recommended before using in rotating motions to insure that heat buildup does not reach destructive levels.

An excellent example of the high efficiency of urethane rubber in stressed parts is a sprocket gear cast of Vulkollan 30 for the chain-drive mechanism of a motorized bicycle. These sprocket gears were centrifugally cast with 0.008-in. tolerance permissible but showed no appreciable wear after 60,000 miles of test operation.

Other applications for self-lubricating urethane rubbers include guides for steering columns of automobiles, gear-shift linkages, combination thrust bearings and seals, and automobile door catches, Fig. 9. Machining to extremely close tolerances is

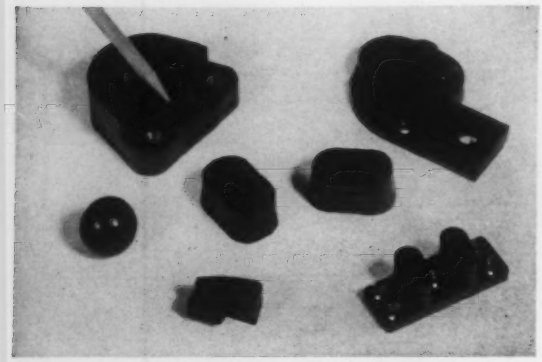


Fig. 9—Automobile door-latch parts of self-lubricating shock-resistant urethane rubber. Parts are flexible enough to permit wide assembly tolerances. Combination of hardness and elasticity makes it possible to use imperfect fittings which could not be tolerated with all-metal construction.

Fig. 10—Urethane rubber surge diaphragm for gasoline filling line. Solvent and oxidation resistance, high tear-strength, and other mechanical properties permit long-life service under severe operating conditions.

not required in applications where urethane rubber is in contact with metal parts. Hardness, elasticity, and strength of urethane rubber permit small misalignments and imperfect fitting of parts.

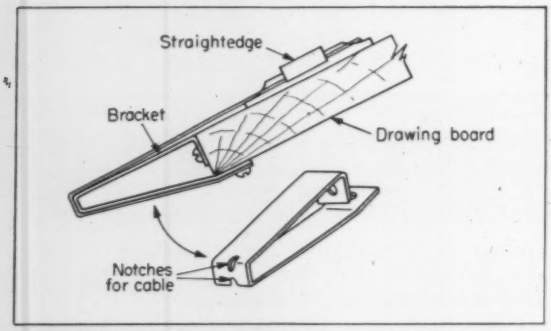
Group 5—Miscellaneous Uses: While Groups 1 through 4 illustrate uses for urethane rubber when specific requirements must be met, the majority of applications for these materials stem from the overall combination of property advantages that can be gained. An example is the air bladder of a hydraulic accumulator used in contact with a variety of liquids such as gasoline and oil as well as air. Another application, Fig. 10, is a gasoline-resistant surge diaphragm for hose filler lines. Urethane rubber's mechanical properties and resistance to oxidation are important to these applications, but difficult to achieve in the proper combination with other rubber materials.

Other examples include valve cores for compressed-air forging hammers in which the high elasticity and compressive modulus of urethane rubber have enabled the cores to outlast the steel covers which contain them. Also, flexible couplings of this material provide resistance to oil, water, and abrasion as well as strength for torsional and shock loading.

Tips and Tecniques

Improving Parallel Rule

In a typical parallel-rule installation, brackets for clamping ends of the cables are fastened to the



front edge of the drawing table. This method has two disadvantages:

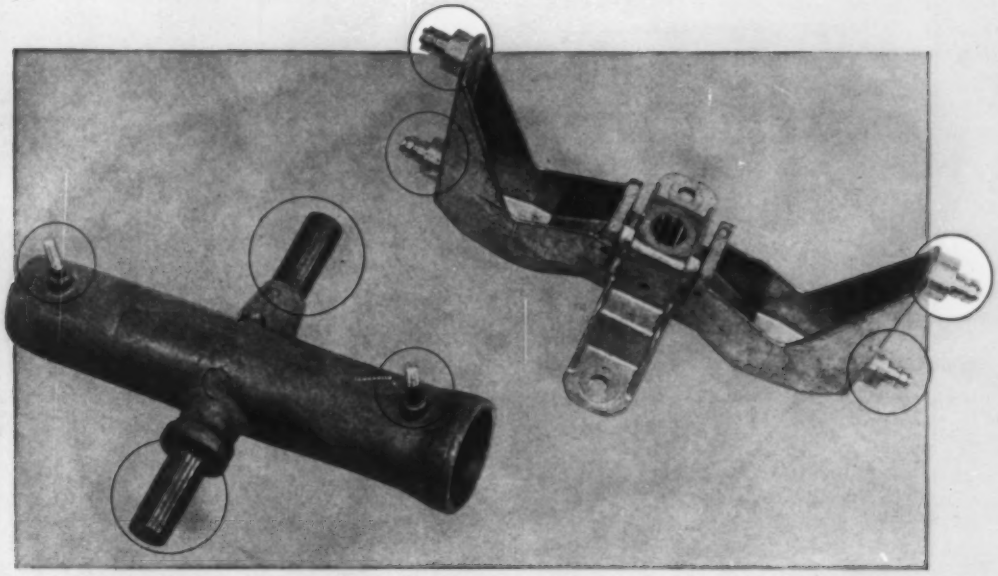
1. As the parallel rule is extended to its lower limit, the rule and cable pinch, or bind. The results are grooves worn into the plastic edge of the parallel rule, cables frayed and broken, and a general mutilation of the rule.

2. Location of the cable limits travel of the rule. Since parallel-rule edges are seldom parallel to each other, this limits work area of the board, because an area equal to the size of the rule is deducted from the total working area.

These disadvantages are particularly objectionable on layout drawings, where space is at a premium.

By making simple extension brackets from bent sheet metal and fastening them to the front edge of the board, these problems can be eliminated. The basic bracket shown may, of course, be modified.—E. R. KASHUBA, *machine designer, Remington Rand Univac, Div. of Sperry Rand Corp., St. Paul, Minn.*

Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables, or photos to: Tips and Techniques Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, O.



Pointers on
selection, design, and application of

Inserts for Die Castings

By E. F. HANNON
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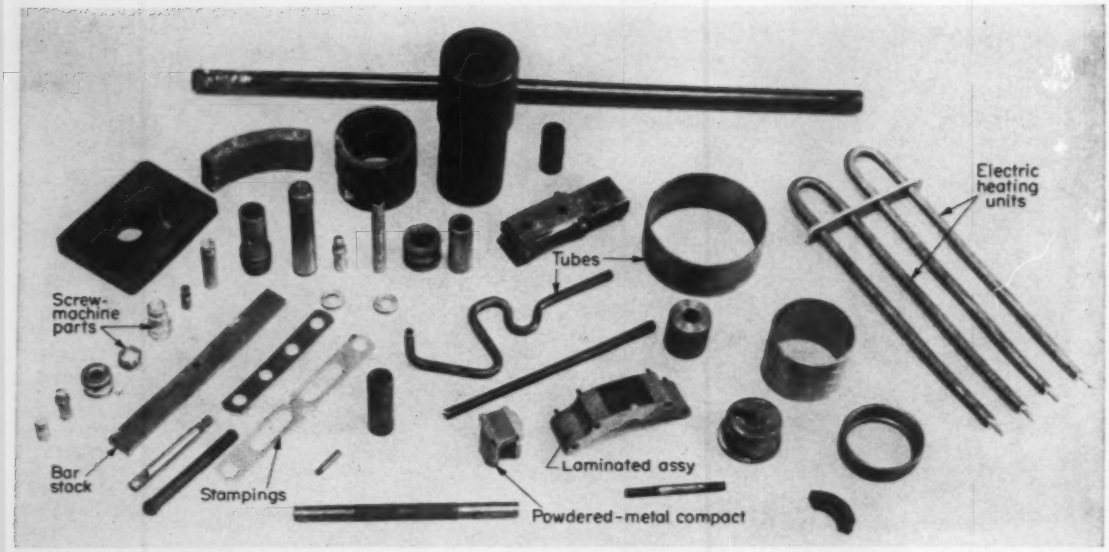
INSERTS of dissimilar metals cast accurately and rigidly in place add greatly to the design flexibility of the die-casting process. The reason for use of inserts is to supply one or more properties not possessed by the die-casting alloy, such as strength, hardness, wear resistance, or improved bearing, frictional or magnetic properties. Inserts are also employed to permit shaping of parts or passages that would be difficult to core or cast, or to produce an assembly more economically than would be possible by other methods.

Where strength is required, die castings for load-carrying parts such as presses, hoists, clamps, and shackles can be made more compact and reliable by use of reinforcing inserts. A good example is a C-clamp bracket, die cast with a steel-stamping insert which adds strength and rigidity to provide for clamping stresses. Magnetic elements and bushings can be used as inserts for zinc or aluminum-alloy die castings to produce parts such as magneto rotors, selsyn motors, and small generators. Rotors are die cast with steel laminations as the inserts. Heating elements, such as Calrod units, can also be used as inserts.

Die castings have been made in which the insert is actually larger than the casting itself, the insert projecting through the parting line of the die. This practice, for certain requirements, permits use of a smaller die and a faster machine than if the whole assembly were die cast.

Insert Materials: Suitable inserts can be de-



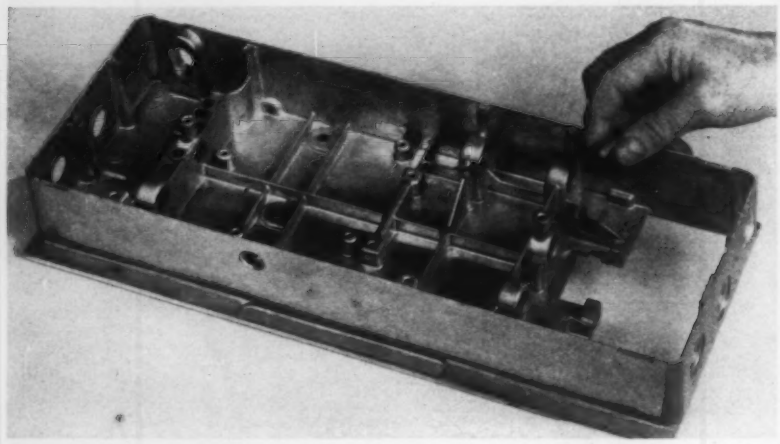


Fig. 1—Above—A wide variety of inserts is commonly used in die casting, including bar stock, tubing, stampings, screw-machine products, and standard items such as fasteners

Fig. 2—Two powdered-metal inserts provide wear resistance for this sewing-machine base plate

signed as bar or tubular stock, either metallic or nonmetallic, or they can be stampings, forgings, or standard stock items such as screws, bolts, and similar hardware, Fig. 1. Inserts of bronze, brass, cast iron, and steel are used in the form of bushings, plates, pins, or cups. Where rubbing or sliding occurs, oil-impregnated, powdered-iron inserts or heat-treated steel are usually specified, Fig. 2.

In some cases, inserts have been designed to turn within the casting. For this application, the insert surfaces are graphited before the metal is cast around it. Use of a special, low-shrinking alloy is another way to prevent locking the casting alloy onto the insert.

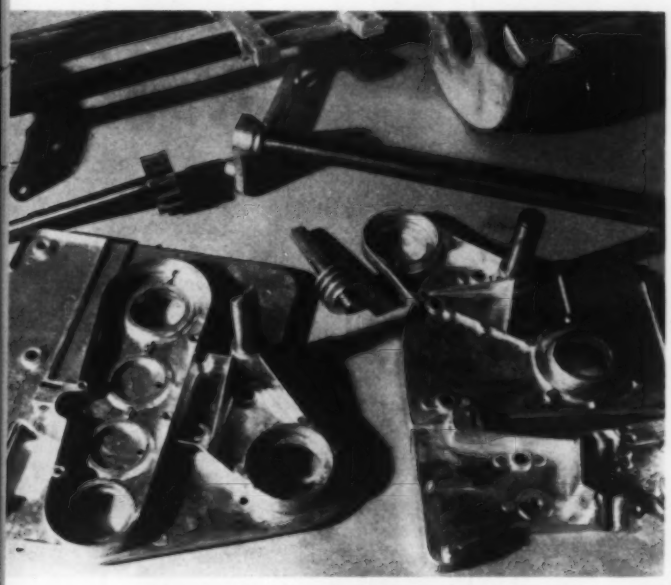
An example of inserts used to increase rigidity and reduce number of separate components to be assembled is the Clemson Brothers lawn-mower frame. This part is cast in one shot, using steel-tube inserts to tie together three separate castings: The engine mounting, side-frame flange, and a gear case, Fig. 3. The steel-tube inserts are knurled in the areas of contact with cast metal, and caps over the tube ends prevent leakage of alloy into the tubes during casting.

Insert Finishes: Steel inserts are generally plated with zinc, chromium, nickel, or copper, although unplated steel inserts are often used where corrosion resistance is not required. Inserts for use in zinc die castings should never be plated with cadmium or tin because the casting metal can become contaminated, resulting in a loss of physical properties. Steel inserts die cast in aluminum or magnesium can be cadmium plated for protection against corrosion. Stainless-steel inserts are recommended for use with aluminum where the presence of salts and moisture could set up electrolytic action. Aluminum inserts are usually given anodic treatment.

Anchorage: Important in all insert applications is anchorage, particularly if the insert is to encounter heavy stress, such as a stud or handle.

Since the bond between insert and casting is neither fusion nor welding, rigidity depends largely upon mechanical locking.

The best method of anchoring a screw-machine or similar part is with a coarse diamond knurl or a straight knurl and grooves; either design will enable the insert to resist both axial pull and turning forces. Holes, deep grooves, or similar breaks in the surface of the insert provide more secure locking than knurling alone. To anchor sheet-metal parts, holes should be provided large enough to allow the molten alloy to pass through and pin the insert to the casting.

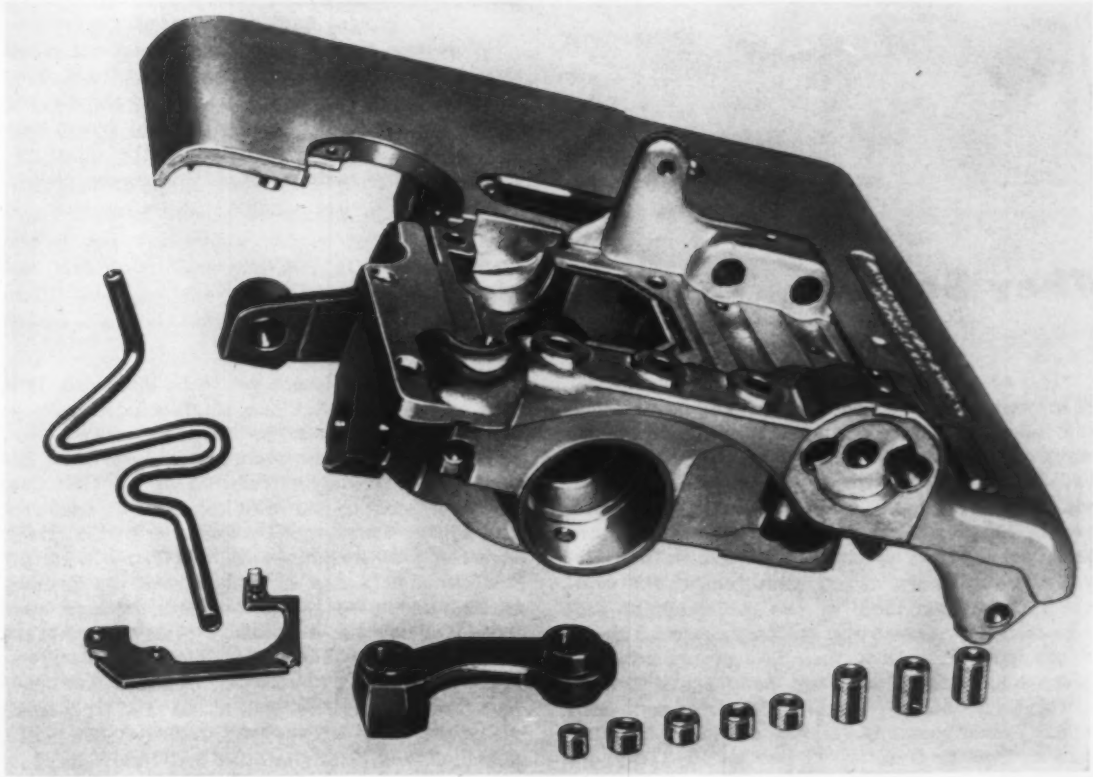


Tubing: Curved passages inside a die casting, impossible to core, can be made by bent-tube inserts whose wall thickness is sufficient to withstand pressure of alloy injection and resist crushing or deformation in handling. Another use of tubing inserts is for lubrication. Sewing machines produced by Wilcox & Gibbs Sewing Machine Co. operate at high speed and a system of forced lubrication through the die casting is required. This requirement was met by integrally casting a copper tube to circulate oil to the proper outlets, Fig. 4.

Positioning and Flash: Casting an insert in place not only anchors it securely but makes it possible to position it in a spot that would be inaccessible after casting. The thickness of casting alloy around the insert must be sufficient to give neccessary support to the insert: About $\frac{1}{8}$ in. min.

Fig. 3—Left—Rigidity and elimination of assembly of lawn-mower frame is obtained by casting three separate parts around two tubular inserts, at one shot

Fig. 4—Top casting of a Wilcox and Gibbs sewing machine contains eleven inserts, including a copper tube to circulate oil

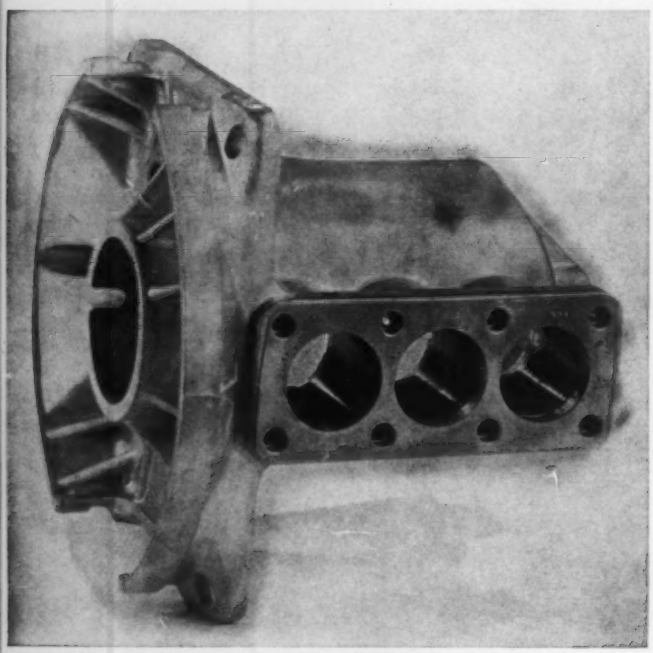


Alloy is prevented from flowing over insert surfaces that are to be exposed by both design of the insert and good die design. On threaded inserts, for instance, a shoulder or similar device on the insert between end thread and die casting will keep flash from filling the threads. In assembly with a mating part, a washer should be placed against this shoulder to reduce torque stress when a nut is tightened on the stud—bearing on the stud itself will prevent tearing the stud from the casting. The end thread should not be closer than 3/32 in. to the casting to avoid filling the threads with molten metal.

The best method of reducing the amount of flash around an insert is by maintaining close control of insert size. However, no special problems are involved in removing flash from an insert. Hollow milling or hand scraping are usually sufficient, but entail extra cost for labor.

Inserts that extend too deeply into the casting can cause distortion by interfering with normal shrinkage of the die casting. Stress concentrations in the casting should be avoided by designing the inserts without sharp corners or projections that are surrounded by thin sections of cast metal.

Fig. 5—Steel or brass bearing surfaces in die-cast parts represent one of the more common applications for inserts, such as the steel tubes cast in place to form piston chambers for this air-compressor block



Tolerances: Parts with inserts usually require greater location tolerances than a part cast without an insert. With an insert, clearance for fitting the inserted piece in the die and the tolerances of the mating surfaces in the die create additional sources of error. Some inserts will fit less snugly than others and variations of their locations will occur. Tubular inserts requiring close ID tolerances should allow for machining after die casting, Fig. 5. The designer must also allow for die wear and its effect on insert location.

Cost Factors: Cost must always be considered when specifying cast-in-place inserts—the determining factor in selecting inserts is the cost when compared with other methods of assembly. Use of inserts will slow down the casting cycle anywhere from 10 to 90 per cent, depending upon the number of inserts used per casting.

Before the final design is made, several points should be weighed: Cost of the insert itself, labor required to put the inserts in place in the die, and slower production rate necessitated by insert location. Only if the benefits outweigh the added cost of these three factors should inserts be chosen.

They Say . . .

"It is sometimes claimed that technical manpower is wasted because scientists and engineers spend too much time on committees and administrative work and not enough on the laboratory bench and the design board. This is an extremely difficult problem to resolve but I believe part of the solution lies in broader education. If the administrators knew more of the principles of scientific methods and the vocabulary of engineers, and if the engineers understood more of the rudiments of economics and possessed the ability to express themselves in clear English, these two groups could do their work without spending many hours in committee trying to explain their points of view to each other."—SIR GEORGE H. NELSON, *president, Institute of Electrical Engineers.*

"The individual is not yet to be discarded. It is from his single mind and single-minded purpose that invention comes, far more frequently than most suspect or that statistics reveal. Look not alone to the great contributions of the 19th Century, but look to our own generation, and even this decade. There was De Forest with his triode, Armstrong with radio circuitry, Land with the Polaroid camera, and so many others, the inventor working alone, the small business growing upon and advancing the individual's other contribution, all in fields in which larger corporate enterprises with vast and proud research facilities were outdistanced by these single minds and the small businesses in which they worked."—C. W. OOMS, *patent counsel, La Salle Steel Co., Hammond, Ind.*

Silver and Silver Alloys?
Precious Metals?
Tungsten and Molybdenum?
Sintered Metal Powders?

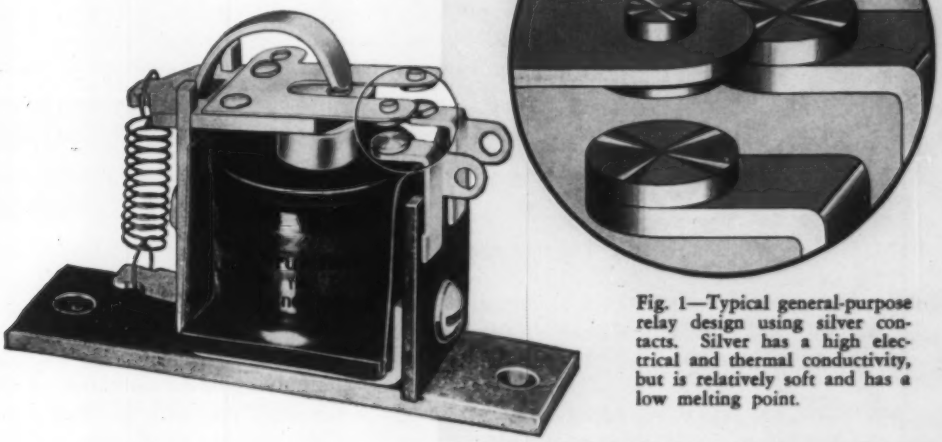


Fig. 1—Typical general-purpose relay design using silver contacts. Silver has a high electrical and thermal conductivity, but is relatively soft and has a low melting point.

How relay application factors affect

Selection of Contact Materials

Besides voltage and current requirements, how and where a relay is used in design can also strongly influence choice of contact materials. The odds of obtaining a standard or special-built relay that meets all functional and reliability requirements will be greatly improved if complete application data form a part of the relay specification.

Presented here is a detailed discussion of relay design, operation and application factors that affect selection of relay contact materials. Characteristics of various contact materials are compared, and the electrical, mechanical, and environmental causes of contact failure are outlined.

By ZEKE R. SMITH
Director of Engineering

Potter and Brumfield Inc.
Subsidiary of
American Machine and Foundry Co.
Princeton, Ind.

THERE are many confusing aspects in selecting a suitable relay contact material, but three seem to stand out: 1. The large number of available materials. 2. The great overlap of material capabilities. 3. The supplier's hesitancy to make blanket statements regarding these capabilities.

Many good, reliable contact-material suppliers will list hundreds of materials in their catalogs. Closer examination will reveal that many of these materials are recommended for the same application. Moreover, there is usally a statement somewhere in the catalog which reads like this, "Tests of promising materials should be made in the specific device under actual operating conditions. When this is impossible, tests in the actual equipment under carefully simulated operating conditions are required to determine that the proposed material is adequate. There is no substitute for this testing." It is doubtful that this last statement can be overemphasized.

Types of Contact Materials

Close examination of the large list of available contact materials reveals four major groups of contact materials, Table 1. These four groups include: 1. Silver and basic silver alloys. 2. The

Meet the Author

ZEKE SMITH was recently elected vice president of Potter and Brumfield Inc. and made director of engineering. Formerly the chief engineer, Mr. Smith is now in charge of all product and applications engineering in the company's plants located in Princeton, Ind.; Franklin, Ky.; and Laconia, N. H. Prior to joining Potter and Brumfield about 4 years ago, the author of this article was associated with Bendix Aviation Corp., Vendo Inc., and the Airborne Instrument Lab. He holds a degree in physics and was a radar instructor for the Army Air Corps during World War II.

precious metals, such as gold, platinum, palladium, and their alloys. 3. Tungsten and molybdenum. 4. The sintered metal powders.

Silver and Silver Alloys: Silver has the highest electrical and thermal conductivity of any contact material. It is easily fabricated, relatively low in cost and, with its numerous alloys, is probably used more than all other contact materials combined, Fig. 1. Unfortunately it has its limitations. It is relatively soft and has a low melting point. In the presence of sulfur it forms silver sulfide, an excellent insulator. And when subjected to excessive current, silver tends to transfer from one contact to another.

Precious Metals: Metals like gold, platinum, palladium, and their alloys are generally used for their low uniform contact resistance and/or high oxidation and corrosion resistance. Where low contact pressures are unavoidable, precious metals are especially desirable. They also generate less electrical noise than the other materials. Their use is limited by low conductivity, relative softness, and high cost.

Tungsten and Molybdenum: These two metals possess outstanding resistance to wear, erosion and welding. Tungsten has the highest melting point, 6098 F, of any contact material and is capable of withstanding arcs that would evaporate other contacts. Unfortunately the electrical conductivity of tungsten is low and it is susceptible to oxidation; it requires high contact pressures and is difficult to work. Molybdenum possesses the attributes of tungsten to a lesser degree, but it is easier to work.

Sintered Metal Powders: A new class of contact materials known as high-conductivity refractory and semirefractory contacts have been opened up with new sintered powder techniques. Sintering provides a singular advantage in that the combinations retain the characteristics of each component to a considerable degree. In conventional alloys, conductivity is always lower than either component material. Sintered contacts of silver and tungsten retain the high conductivity of silver and the high arc resistance and freedom from welding of tungsten. The only apparent limitation of these materials is the slight loss each attribute suffers in the combination, i.e., the loss of some conductivity and some arc resistance. At present, the only serious limitation of sintered materials seems to be the inability to retain their attributes to perfection. Even with this limitation these materials have permitted tremendous advances in many applications.

Causes of Contact Failure

It might appear from the discussion thus far that selecting a suitable contact material is not as difficult as it is purported to be. But now problems begin to arise. They arise from the contact as a circuit component, from the major causes of contact failures, and from the individual factors that influence these causes.

As a circuit component, contacts are effectively a resistance with two extreme values. These values correspond to the open and closed-contact conditions where the closed condition is a low resistance value, usually less than 1 ohm, and the open condition a high value in the order of megohms.

To meet these requirements contacts must be held closed with some minimum force and must be separated by some minimum spacing when open. These two conditions must be maintained constant when the contacts are at rest. Transfer from one condition to the other should be as abrupt and as free from oscillation as possible. The contacts of every relay must satisfy these conditions, and any departure represents either the end of the useful life of the relay or defective performance of the system in which it is working. Contact failure may be said to occur when the closed resistance is too high or the open resistance is too low.

Heat: There is one prime cause for the failure of relay contacts—the dissipation of electrical energy. This phenomenon manifests itself in one of four ways: 1. Excessive contact resistance. 2. Contact erosion. 3. Contact transfer. 4. Contact

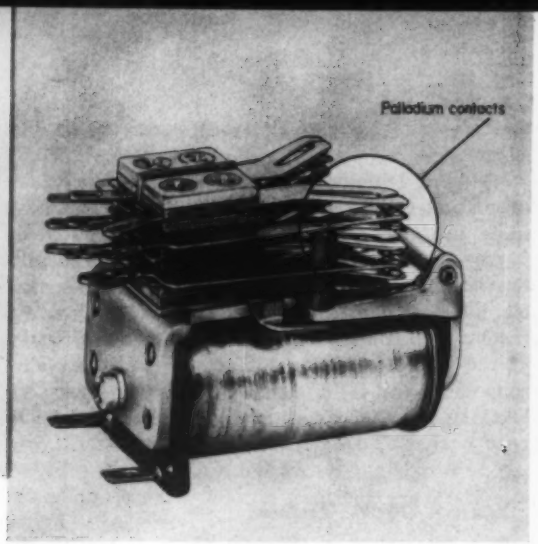


Fig. 2—Relay designed for dry-circuit applications. Contacts are made of palladium and contact arms are bifurcated.

sticking and welding. The relationship of the causes of failure and the factors affecting them are shown in Table 2.

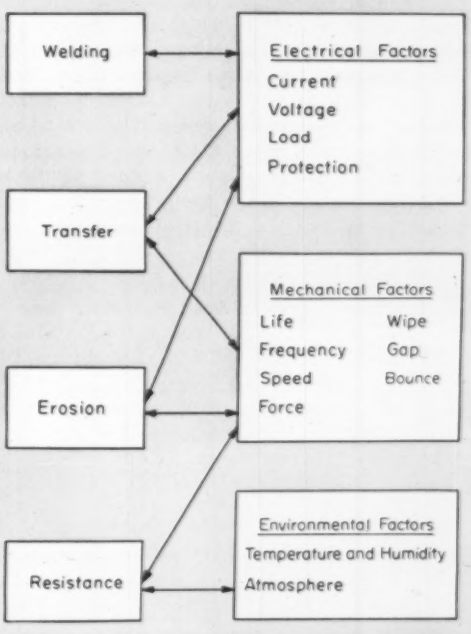
Resistance: Contact resistance may be defined in terms of specific resistance of the contact material, the constriction resistance, and the film resistance. The specific resistance is the function of contact material composition. Constriction resistance is the resistance across the interface or the area where the mating contacts touch. Film resistance is the result of nonconducting or semiconducting particles between the contacts. These films are chemical or mechanical. Chemical films are a result of oxidation, corrosion, or surface reaction to foreign material, while mechanical films are formed by dust, oil, or other foreign particles. Specific resistance changes only with variations in material. Constriction resistance can be changed by varying the force between contacts, by decreasing the hardness of the material, and by varying the contact area. Film resistance can be changed by varying wipe or slide, increasing contact force, bifurcating contact arms, and by eliminating foreign materials from the contacts.

Erosion: Contact erosion can be of two types—electrical and mechanical. It is one of the greatest factors contributing to contact failure. An average telephone relay contact with 20 grams contact pressure loses approximately 1 mil-inch for every 100 million operations due to mechanical wear, Fig. 2. This is minor when compared to electrical erosion which is much more common and usually more damaging. The primary source of electrical erosion is arcing contacts. This arcing results in a minute amount of vaporization with every operation and causes the loss of some of the metal. This arc can be defined as a discharge whose cathode mechanism depends largely upon thermionic emission. Unfortunately the exact mechanism of material loss in this discharge is not known. It is

Table 1—Basic Groups of Contact Materials

Groups	Type of Relay	Properties
Silver and silver alloys	General-purpose relays	1. High electrical and thermal conductivity 2. Low contact resistance 3. Low transfer rate 4. Low cost
Platinum, gold, and noble metals	Sensitive relays	1. High corrosion and oxidation resistance 2. Low contact resistance 3. Require low closing pressures
Tungsten and molybdenum	High-speed interrupters and aviation control relays	1. High erosion resistance 2. High strength and hardness
Sintered metal powders	Any relay used under high-load conditions	1. Permit combining materials to obtain the best characteristics of each

Table 2—Causes of Contact Failure



associated with evaporation, the degree of ionization of the evaporated particle, and ion bombardment.

It is generally agreed, however, that anode losses caused by the discharge are related to the boiling point of the metal and can be explained by vaporization. This loss of material is important, not only to contact life but also to the dielectric strength of the surrounding mechanism. The characteristics of arc erosion vary with different contact materials depending principally on melting and boiling points. However, the rate of arc erosion for a given material is proportional to the circuit current and the frequency and number of operations.

Contact Transfer: This is the term applied when contact material moves from one contact to another. In ac circuits, it does not generally have a definite direction of transfer unless one contact is operating at a higher temperature than the other. In this case, the transfer moves in the direction of the cooler contact. Contacts operating in synchronism with line frequency will transfer since they always break at the same point in the wave form. This, of course, is the same as breaking a dc circuit. In dc circuits, as shown in Fig. 3, the transfer of contact material may occur in two ways: 1. To the negative contacts, generally called bridge transfer or pitting. 2. To the positive contacts, generally called arc or positive transfer.

Negative or bridge transfers occur when the contacts are operated below the characteristic minimum arc voltage or current values for a particular material. This results in a sharp spike building on the negative contact with a matching hole in the positive contact, Fig. 3*a*.

At currents and voltages above minimum arc voltage or current values, positive transfer occurs as a large mound covering a large area, Fig. 3*b*. The greater the arc energy, the greater the positive transfer. Negative transfer is not well understood. It is generally attributed to contacts melting at the moment of separation due to high contact resistance caused by low contact pressure. The molten bridge tends to deposit on the negative contact since it is the cooler one at the instant of separation, but the material is transferred to the positive contact due to electron flow in the arc.

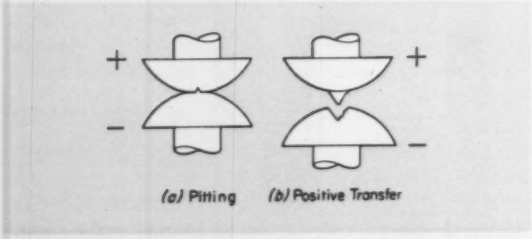


Fig. 3—Two causes of contact material transfer. Transfer from the positive contact to the negative one, which is called bridge transfer or pitting, is shown in *a*. In positive transfer, *b*, material moves from negative to positive.

Welding: Sticking or welding is a major cause of contact failure and normally occurs by one of three processes: Mechanical hang-up, butt welding, or arc welding. Mechanical hang-up is usually the result of transfer and the subsequent mechanical interlock caused by contact wipe. Butt welding results from the heat produced by high resistivity at the interface of the contacts. This may also cause electrical welding. Arc welding is caused by bringing together two molten contacts which have been heated by an arc discharge.

Electrical Design Factors

The electrical, mechanical, and environmental parameters of the relay affect contact failure and thus have a direct bearing on the choice of contact material. Current heads the list of electrical parameters.

Current: The nature and value of current at make and break are major factors in selecting satisfactory contact materials and, therefore, the values of transient or instantaneous currents must be considered when making this selection. In motors and incandescent lamps, for example, current inrush on closing may be 5 to 20 times normal.

As a prime component of electrical energy, current directly affects all four causes of contact failure. Approximately 99 per cent of the energy dissipated at the contacts is in the form of heat generated by the I^2R effect of constriction resistance. If the material is such that contact surface film increases with temperature rise, a typical feedback circuit is engendered whereby the surface film increases the resistance, the resistance increases the temperature, the temperature increases the surface film, etc. In some cases this effect is disastrous. Normally the contact temperature rises during operation until it reaches a state of equilibrium where the radiation and conduction losses equal the heat input of the constriction resistance and arc energy. Arc erosion, the tendency to weld or stick, and contact erosion all occur in direct proportion to the amount of energy dissipated at and through the contacts, and hence in direct proportion to the contact current.

Voltage: Contact operating voltages are important in selecting a suitable contact material. All materials possess a characteristic arcing voltage in the 10 to 20-v range. If the maximum voltage is below this range, arcing will not occur. Above this voltage, arcing and loss of contact material caused by arc erosion must be expected.

Load: The type of load, such as induction, capacitive, resistive, lamp load, or motor load, should be known. Inductance complicates the problem of contact break since it releases a considerable amount of extra electrical energy that the contacts must handle. This affects the transfer rate, the rate of erosion, and the interface resist-

ance of the contact. A capacitive load complicates the problem by causing heavy current inrush. This is also true of the lamp load. Motor loads compound the problem. While these loads are basically inductive, they also have a heavy starting current inrush. Capacitive and lamp loads tremendously complicate or increase sticking or welding. A resistive load behaves consistently and can be safely predicted.

Contact Protection: Contact life can be materially extended through the use of auxiliary contact protectors or arc suppressors, Fig. 4. A properly designed protective circuit will greatly reduce the burden on the contacts and certainly should be given consideration when selecting a contact material.

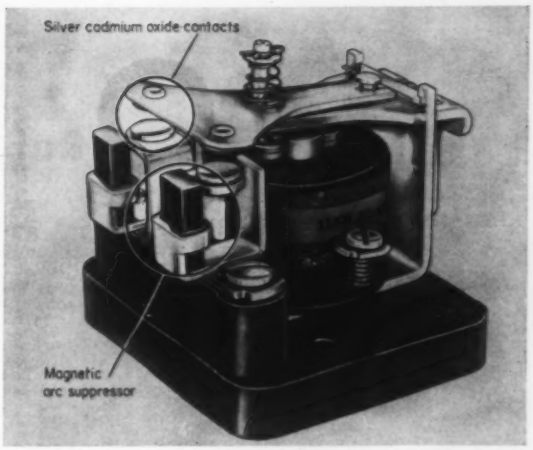


Fig. 4—Double-pole, single-throw relay with auxiliary contact protectors or arc suppressors to extend contact life

Mechanical Design Factors

Mechanical factors greatly affect the choice of contact material. The number of operations expected and the frequency of operation per unit of time must be spelled out in detail. High frequency of operation increases the heat and high local temperature problems. Extremely low frequencies of operation, like those sometimes used in signal equipment, increase the possibility of high contact resistance due to contact surface film.

The mechanical forces that close the contacts affect the choice of contact material. These forces determine the use of a hard or soft material.

Speed of operation affects the circuit and thus the contact material. In dc circuits a slow rate of make or break produces greater arcing. In ac circuits too rapid a break may produce excessive induced voltage.

Contact wipe or slide must be considered. In many cases this action breaks down oxide or other chemical films on the surface contact, whereas in others, this same action will cause mechanical interlock or excessive wear. The contact gap determines the maximum voltage capabilities of the contacts and becomes particularly important in inductive circuits.

Contact chatter or bounce is a major mechanical problem. Contact bounce forces the contacts to make and break several times per operation instead of just once. This tends to decrease contact life substantially and is the prime originator of many contact welds.

Environmental Design Factors

The atmosphere that contacts work in has an appreciable effect on contact operation and hence the choice of material. Gases or fumes have a tremendous effect on contact resistance. Sulfur fumes, for example, are particularly detrimental to silver and many silver alloys because they form highly resistive silver sulfide. Hermetic sealing does not slove all problems concerning gases and fumes. Once a relay is hermetically sealed, it lives its useful life in the same confined atmosphere. The organic materials, frequently used in relays, give off fumes which are trapped in this atmosphere. Once these fumes deposit themselves on the contact surface, the contact resistance increases rapidly. This combined set of circumstances is particularly troublesome in dry circuits.

The ambient temperature requirements for relay contacts are becoming more important every day as the military applications push these requirements higher and higher. Generally speaking, the ambient temperature and humidity conditions aggravate the contact resistance and thus frequently lead to contact failure.

Summary

In general, silver is almost always used for general-purpose relays. The noble metals are selected for their high resistance to oxidation and corrosion. These materials give maximum sureness of operation in relays designed for maximum sensitivity. In a few isolated and special cases like high-speed interrupter contacts, tungsten and molybdenum can give fantastic results in terms of life. Generally speaking, sintered metal powders are most used in higher current applications. They require more contact pressure to guard against interface resistance and thus are used very little in low-powered structures for light-duty relays.

These generalized requirements become confused by conflicting requirements; for example, dry-circuit operation combined with long life led contact material suppliers to combine properties and thus produce an alloy. For example, platinum gave way to palladium and then to gold-plated palladium. Other requirement combinations have led to other alloys.

Finally, as pointed out previously, there is no substitute for testing a promising contact material in the particular application for which it is intended.

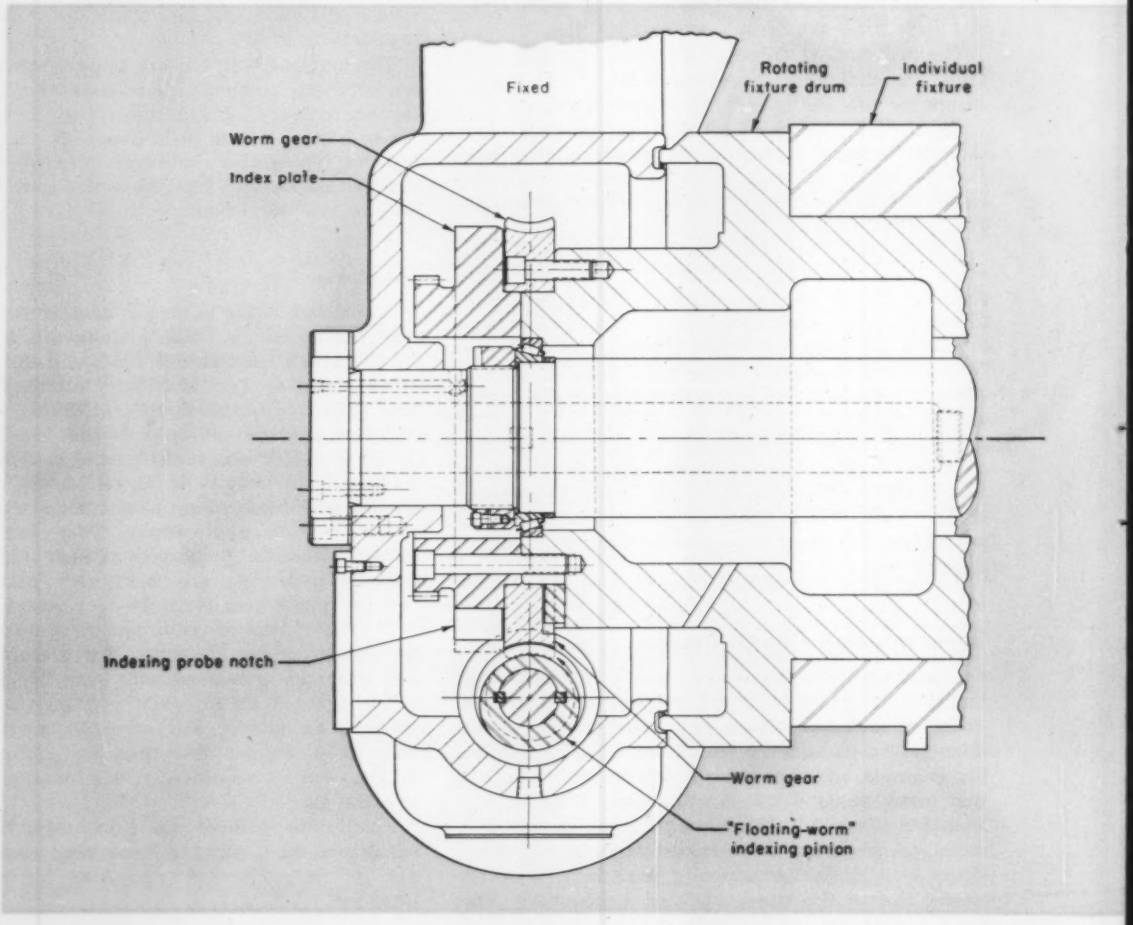
Rubber Bumpers Shock Cushion

INTEGRATED TIME-DELAY SWITCHING used in the control system design maintains accuracy of index positioning and timing.

Indexing is from a rotating pin-locked plate. The plate is driven by a continuously rotating ac motor through an intermittently operated electric clutch and the floating-worm-and-gear indexing drive. An electric brake, which is mounted on the same shaft, quickly stops the worm drive after the electric clutch is disengaged from the drive motor.

After starting the hydraulic pump, index and chain-drive motors, the operator preselects an **automatic** cycle on the selector switch panel and manually loads two parts into a spring-loaded nest which retains the part for clamping.

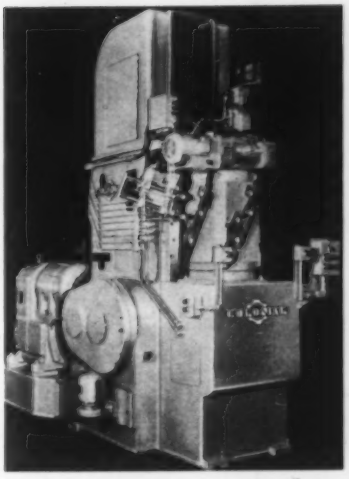
With the machine in position for starting, the operator depresses the dual **cycle-start** buttons starting the **automatic** cycle. First, a solenoid is energized, pulling the index lock-pin out. This action trips a switch which de-energizes the **index lock-pin out** solenoid allowing the index lock pin to go back in under spring pressure. At the same time, the **index-clutch** solenoid is energized, starting an index. The index rotates at normal speed with the index lock pin riding on the side of the hardened index plate until a limit switch is tripped, de-energizing the **index-clutch** solenoid and energizing the **index-brake** solenoid. This slows the index plate down, allowing it to coast into the located position and sending the shot pin into the slot under spring pressure. When the index lock pin gets in under spring pressure, a switch is tripped, energizing the **index lock-pin in** solenoid which sends it home under hydraulic pressure.

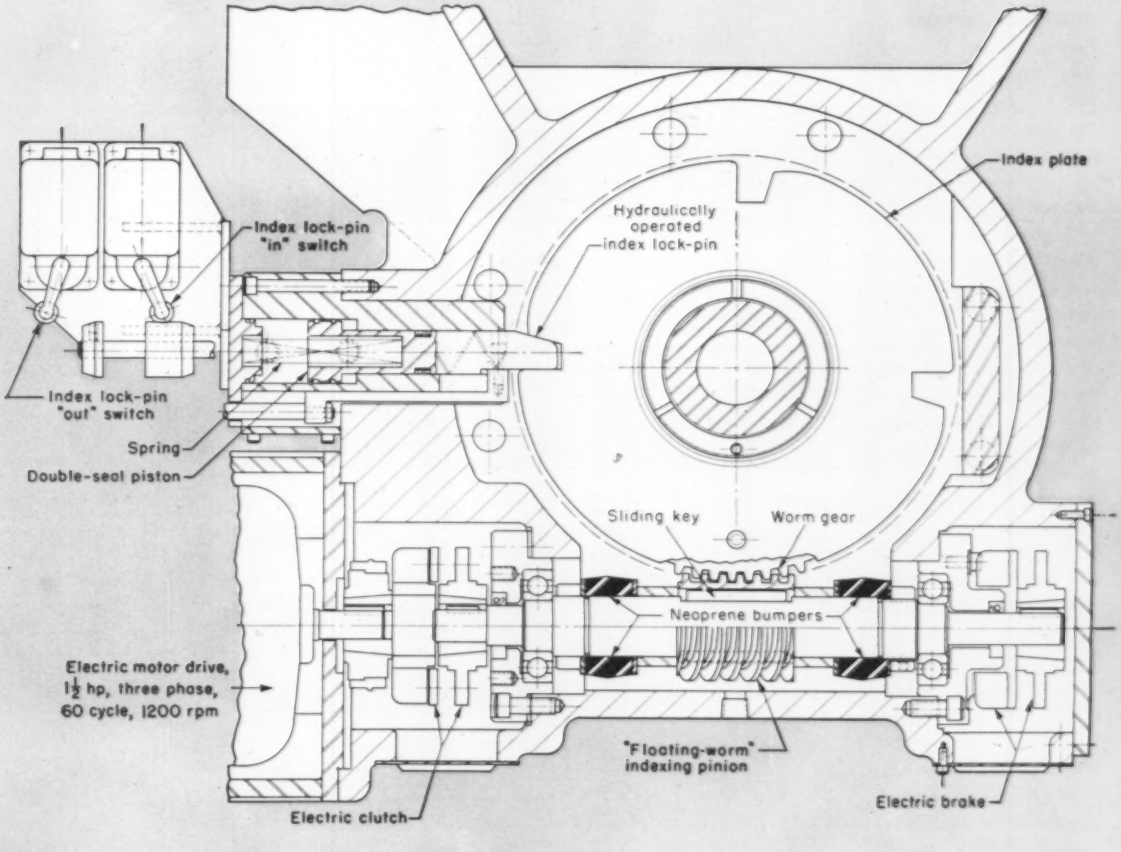


Indexing Worm-Drive Pinion

HIGH-SPEED INDEXING with minimum shock is provided by a novel "floating-worm" index drive. Developed by the Colonial Broach and Machine Co., the worm pinion driving the indexing fixture is keyed to the driving shaft with two 5/16 x 5/16 x 3-in. keys. Slight clearances between the keys and the worm pinion permit it to slide axially for a short distance to reduce starting and stopping shock loading when the machine is indexed. By compression-spring action, ring-shaped neoprene bumpers mounted on the worm drive shaft at each end of the floating-worm assembly limit the amount of axial sliding, provide a cushioning effect, and automatically keep the worm centered.

AUTOMATIC BROACHING of eight oil groove slots in an automotive rocker-arm shaft is accomplished with this machine tool at the rate of 640 per hr. The vertical-chain, surface-broaching machine weighs 10 tons, has a 160-in. stroke with a four-station indexing fixture. Shafts are manually loaded, automatically probed for true position, broached, and automatically air ejected in the 9-sec cycle time.





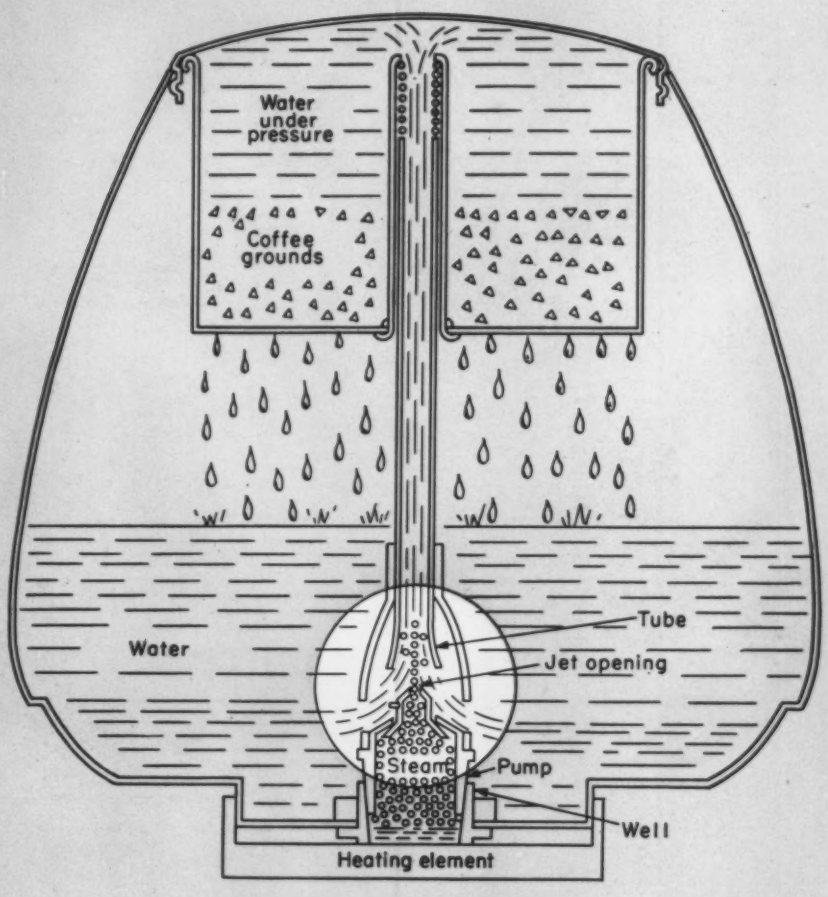
Steam Jet Pumps Hot Water

AUTOMATIC CIRCULATION of hot water through coffee grounds is accomplished by a novel steam-jet pumping process. Developed by the M. H. Graham Corp. for their new Jet-O-Matic coffeemaker, the pumping system quickly circulates a large volume of water through the grounds without bringing the water temperature to the boiling point. Temperature of the water ranges between 160 to 197 F.

Unit is less than 8 in. tall and is designed with a low center of gravity to prevent tipping.

PUMPING ACTION is initiated when three or four drops of water in the heated steam well are converted into steam. Under pressure, this steam passes through the jet opening, at high velocity, forcing about 3/4 cup of water per cycle into the tube opening, up the tube, and out the top, falling onto the coffee. Hot water actually fills the basket as cycle is repeated three to five times, depending on quantity of coffee required.

The pop-up basket is designed for easy removal and also serves to lock on the cover. Spring tension keeps the basket locked tight against the cover so that the large volume of water pumped into the basket is actually forced down through the grounds under pressure.

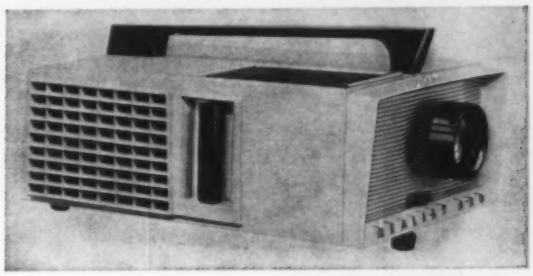


Projector with Long, Low Look Uses Horizontal-Burning Projection Lamp

LOW-COST, SMARTLY STYLED Realist 620 projector is designed to use horizontally mounted 300-w projection lamp. Developed by Realist Inc., a subsidiary of David White Instrument Co., the unit was designed to show slides in all sizes from 35 mm to 2¼ by 2¼. Styling was done by Jack Collins of Milwaukee, Wis.

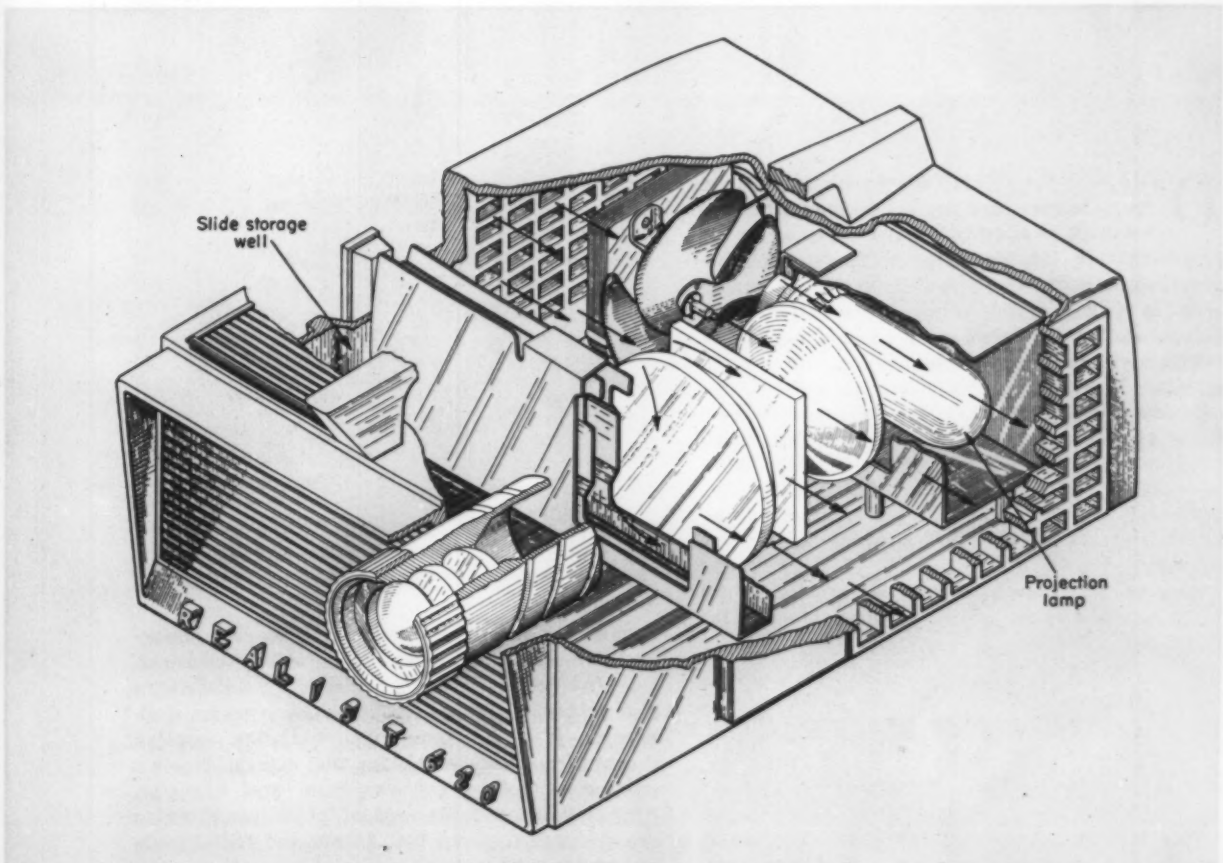
Only 6 in. high and weighing 9 lb, the projector is constructed of die-cast aluminum with a hard-baked enamel finish of antique white colored over-all with brown trim and white lettering on the nameplate.

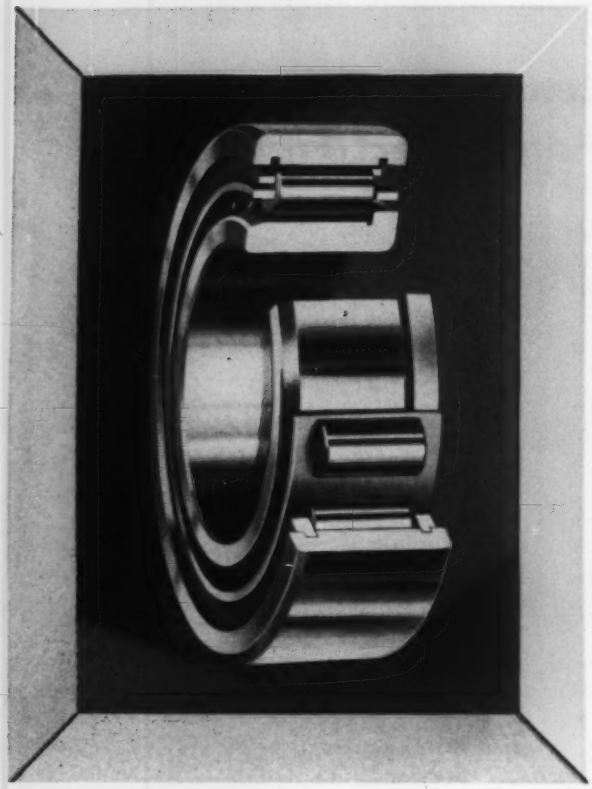
A slide-storage well is built into the top of the projector housing in front of loading slot. A metal cover can be slipped over loading slot and storage well openings.



QUIET COOLING of lamp and other elements is accomplished with a fan designed with oversized and overlapped fan vanes. Also, the fan motor is rubber-cushion mounted to absorb vibration. Cooling air is drawn in through the louvers on one side and is blown across the lamp, condensing lenses, heat-absorbing glass, and the slide itself.

When slides are being projected, some light from the projection lamp spills out through the louvered sides of the projector, making it easy to see and handle slides.





Characteristics of

BASIC ROLLER BEARINGS

By JOHNNY RIDDLE
Tulsa, Okla.

DEMANDS for greater speeds, improved accuracy, longer life, higher temperature, and balanced performance have led to many improvements in today's roller bearings. Such improvements may be attributed to higher standards in metallurgical control, production techniques, and the refinement of bearing lubricants.

This article summarizes basic and modified types of roller bearings, and considers variables of design which affect performance. It can serve as a guide to selection of general types. Design variables of exacting nature, which should always be considered prior to final selection, include axial and radial fitup variations, cage properties and designs, special metals, and contour of rollers (straight or crowned).

Also to be considered are the special manufacturing techniques which may be employed to adapt roller bearings to unusual needs.

TAPERED ROLLER BEARINGS

Single-Row Bearings

This type is the tapered roller unit used most widely in rotating machinery, Fig. 1. Almost endless modifications are possible by merely changing dimensions or angles of the rolling elements. Unit balance, however, is achieved by maintaining a fundamental relation between the various components of the bearing. One variation employs the pin-type cage and uses the highest possible number of rollers for maximum load capacity. All tapered roller bearings of radial construction are designed to carry both thrust and radial loads or angular combinations.

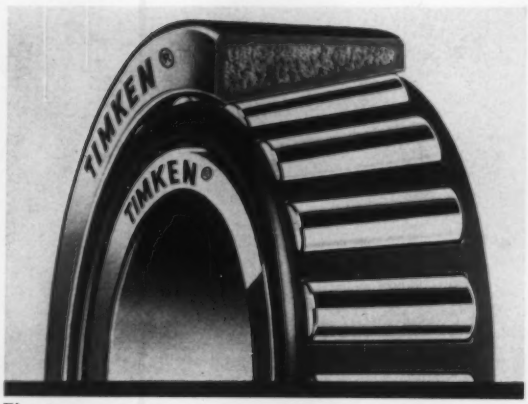
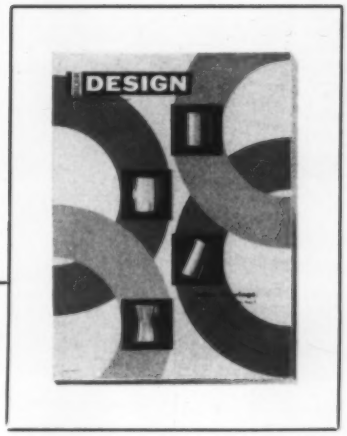


Fig. 1

A review of fundamental types of roller bearings, emphasizing performance characteristics



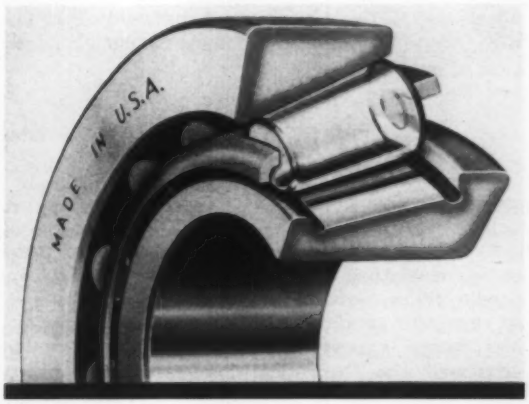


Fig. 2

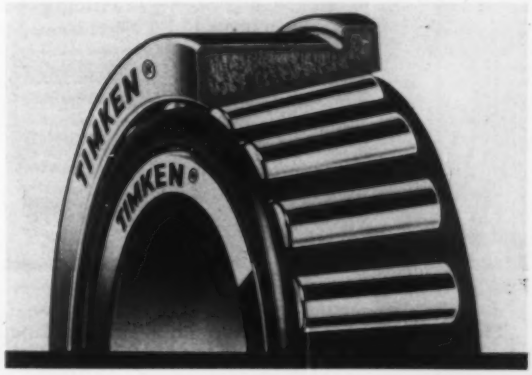
Single-Row, Steep-Angle Bearings

The steep angle type, Fig. 2, was developed for applications where high thrust capacity is required —power takeoffs, worm and bevel gear shafts— combined with an appreciable radial load. It differs from the conventional single-row type in that the angles of the raceways, as well as the rollers, are quite steep. Though designed for very heavy thrust loads, the fundamental principle of the tapered roller unit is retained.

Flanged-Cup Bearings

In some applications, particularly in precision machine-tool spindles, it is difficult to machine conventional cup seats to a shoulder and maintain the desired accuracy. Unit tolerances may be maintained, however, by boring straight through the

Fig. 3



housing and facing an outside seat at right angles to the bore. This design also facilitates assembly when space limitations do not permit other types, as in certain gear-box designs. It is produced in a wide range of sizes and is used with conventional cones, Fig. 3.

Two-Row, Double-Cup Bearings

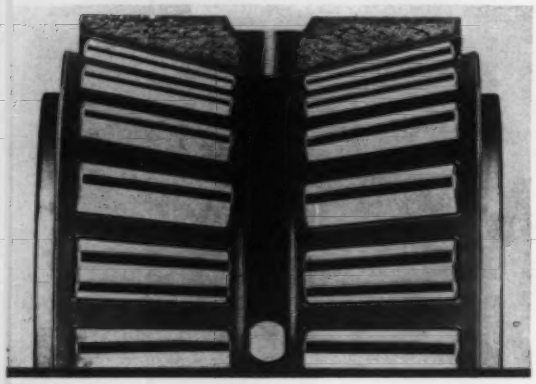


Fig. 4

This unit employs a double cup with two conventional cones, Fig. 4. Two assemblies are obtainable, one differing in that a spacer is introduced between the cones so that the setup or running clearance is established at the time the bearing is manufactured. The other, with no spacer, requires proper setup by some adjusting device. When compensation for shaft expansion is required, this unit is frequently used. The cones are locked in position, and the cup is free to float in the housing. Under such conditions, the opposite bearing is normally fixed.

Two-Row, Double-Cone Bearings

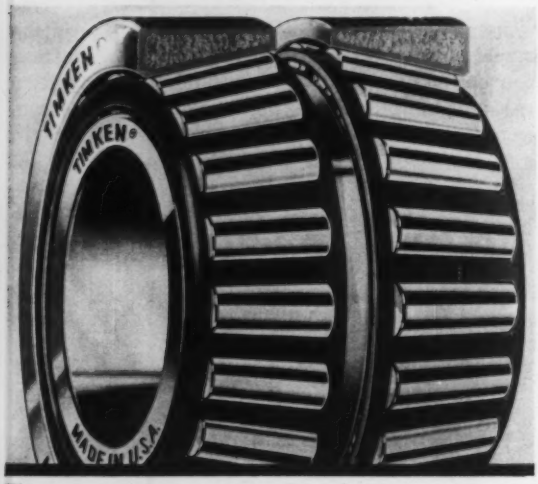


Fig. 5

This unit is frequently selected for positions where it is necessary to secure the capacity of a two-row bearing, yet obtain a simpler mounting than two standard, single-row bearings, Fig. 5. It is also often used on the fixed end of a shaft when an allowance must be made for shaft expansion. When so used, the opposite bearing is usually one of the double-cup units set up to float.

Four-Row Bearings

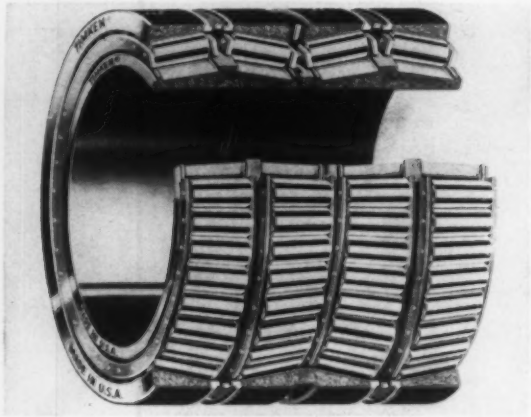


Fig. 6

This bearing was developed for applications where maximum capacity is required in a limited space, Fig. 6. The arrangement is similar to 2 two-row, double-cone bearings set side by side, but with a double cup carrying the load from the two inner sets of rollers and single cups carrying the load imposed on the two outer sets of rollers. In some slow-speed mountings, these bearings are mounted without cup and cone spacer rings. However, spacer rings are recommended in most applications, as this provides a factory-adjusted unit with proper running clearance established at the time of manufacture.

NEEDLE ROLLER BEARINGS

Drawn-Cup Units

The term "needle bearing" has come to mean, in nomenclature perhaps too loosely used, any needle roller bearing in which there is no cage or separator retaining the individual rollers. Cageless design extends the effective bearing-contact area and the theoretical load-carrying capacity. Roller alignment is maintained through the use of controlled circumferential clearance or clearance between rollers. Some modified designs employ a center guide member.

Many sizes are available, with or without inner race members. The drawn cup unit, Fig. 7, is sensitive to housing and shaft inaccuracies, and should be installed with care. It is designed for basically radial loads. However, a recently developed needle thrust bearing may now be had in many sizes.

Precision and extraprecision units are available,

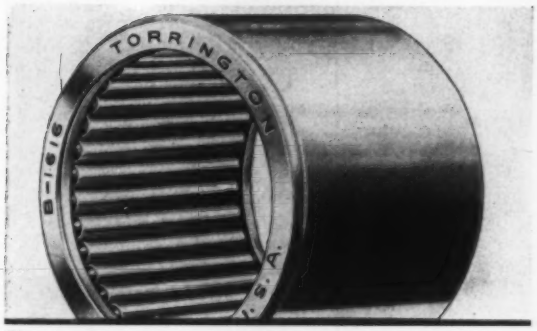


Fig. 7

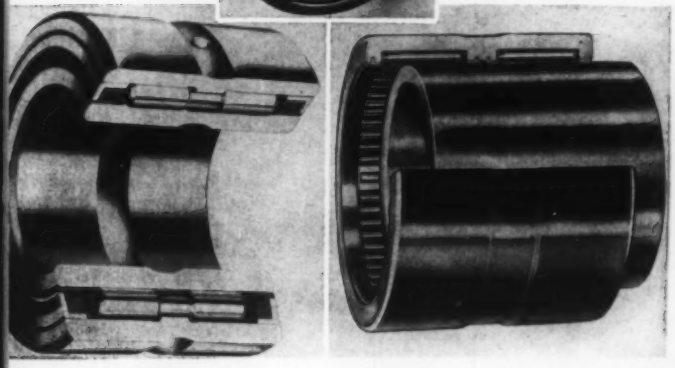
and speed ranges are wide when the unit is properly mounted and lubricated. Bearings are sometimes made with corrosion-resistant finishes and materials.

Heavy-Duty Needle Units

Fig. 8

Fig. 9

Fig. 10



Nomenclature of these units varies widely, according to the manufacturer. These are needle units with substantially heavier sectional depth, Fig. 8. Roll ends may be one of several designs, and end rings may be integral or separable. Center guide members are available in certain designs, and built-in end seals are an added feature in others, Fig. 9. The relatively heavier outer ring withstands shock loading, and controlled assembly clearances permit mountings of high running accuracy.

The heavy-duty assemblies may be obtained with or without inner ring members, as requirements dictate. Multiple-row units, Fig. 10, are also available in many sizes.

Caged Needle-Bearing Units

Cages are employed in this type to reduce internal friction and assure more positive roller alignment. The cage itself may be one of several materials and designs, Fig. 11. Use of a cage reduces effective bearing support area, but operating advantages are gained in other respects. Here again, roll-end designs may vary. Caged units are somewhat less sensitive to uneven loading, and may permit speed extensions. Multiple-row units are made, and outer and inner ring components are normally interchangeable with standard noncage designs.

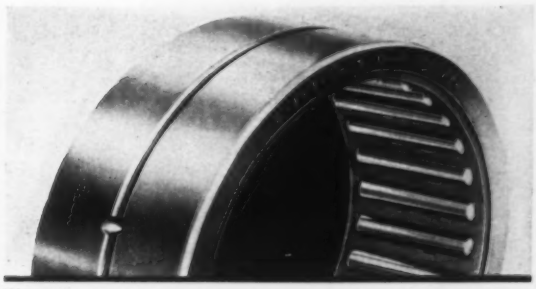


Fig. 11

Needle-Bearing Cam Followers

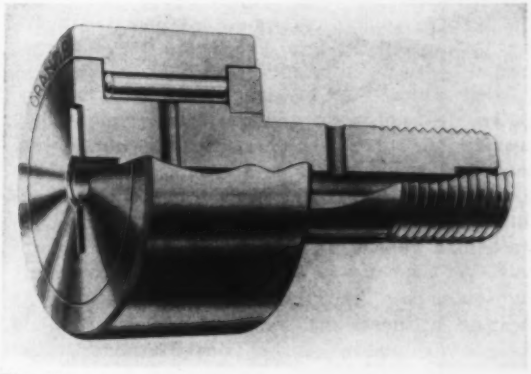


Fig. 12

These units are designed to provide high radial load-carrying capacity and maximum resistance to shock, while giving antifriction freedom to cam or track movements, Fig. 12. The stud permits cantilever mountings, and may be of varying thickness for standard or heavy-duty service. Some designs feature built-in seals. Thus, a complete subassembly incorporating a needle bearing is readily available as a standard stock item for design into mechanisms requiring cam action.

Cam-Yoke Rollers

This needle-bearing design, Fig. 13, increases the adaptability of cam-follower bearings to all types of automatic machinery. Internal construction is similar to that of cam followers, but with a heavier outer-ring section. An inner ring re-

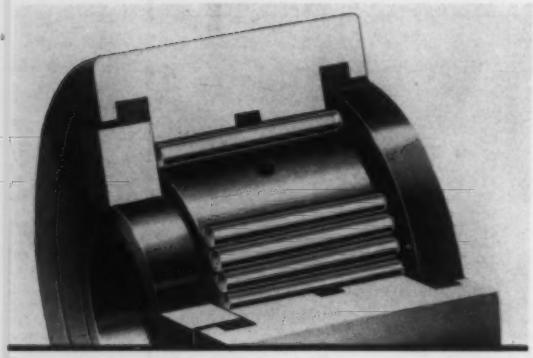


Fig. 13

places the stud for shaft mounting. Yoke mounting is popular for this bearing.

Loose Roll Needle Units

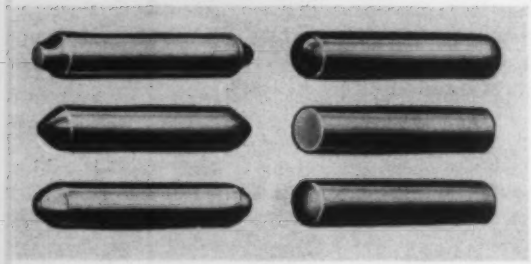


Fig. 14

These units, Fig. 14, are widely used in automotive transmissions and universal joints. They provide one of the highest-capacity antifriction bearing devices obtainable at low cost. Design requirements and installation facilities normally influence the decision to use loose roll needles. Ultimate load capacity in a limited space is obtainable, but capacity is directly influenced by shaft and outer-race hardness and finish, as well as locating washers, spacers or shoulders. Roll-end designs vary and may be spherical, flat, ball, crankpin, conical, or trunnion.

SPHERICAL ROLLER BEARINGS

Radial Spherical Units

A spherical roller bearing is particularly suitable for carrying heavy loads. It is a double-row design, both rows of rollers having a common spherical raceway in the outer ring, Fig. 15. Thus, it is inherently self-aligning.

Progressing from common bore sizes, several series are available, giving a wide choice of unit capacities. Thrust capacity is good, particularly in the wider series. Most series are manufactured in straight and tapered bore, the latter normally used with an adapter mounting but occasionally applied directly to the shaft.

Internal design features—radial clearance, cage

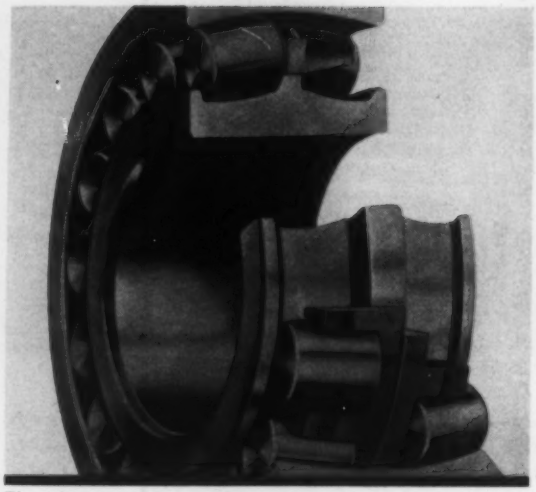


Fig. 15

material and design, etc.—are critical variables. Built-in clearances are especially important, and require the keenest evaluation before the spherical unit is designed into a mounting.

Oil holes and grooves in the outer ring member, along with special-tolerance outside diameters for exacting service, are available in some series.

Thrust Spherical Units

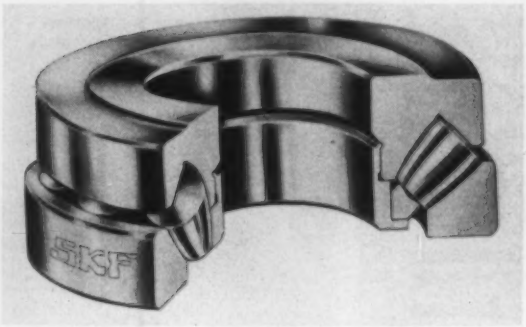


Fig. 16

A development of the last few years, this unit provides extremely high load-carrying capacity. The cage is centered and held by a sleeve on the inner ring, Fig. 16. This sleeve also holds the inner ring and roller set together as a unit which is easy to mount. The unit is self-aligning around the center of the spherical roller path of the outer ring. It is very similar to the radial spherical bearing, of which it is actually a variation with an exceptionally large contact angle. The nature of roll-end and flange-guide surface contact may require lubricant specifications somewhat different from those considered adequate for a radial spherical bearing.

CYLINDRICAL ROLLER BEARINGS

A wide range of cylindrical roller units is avail-

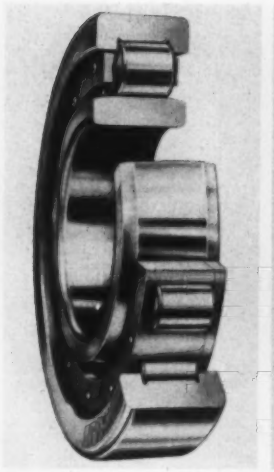


Fig. 17

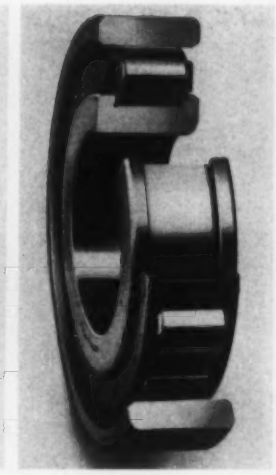


Fig. 18

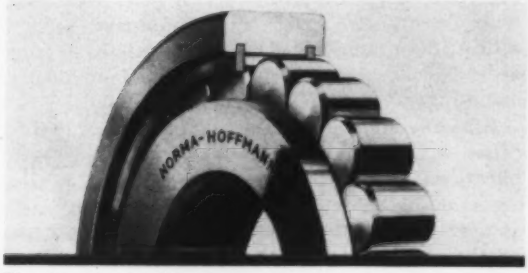


Fig. 19

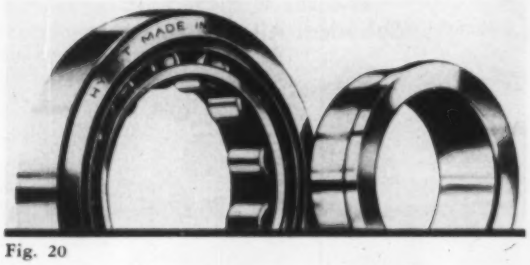


Fig. 20

able, and the designer may incorporate one or more features which will facilitate installation and removal.

There are about ten major type variations. Four have separable inner races, Fig. 17; two have separable outer races, Fig. 18; and four are non-separable, Fig. 19. Occasionally the units are broken down and the rollers applied directly to the shaft, Fig. 20, or to the housing when these members are of proper hardness and finish.

Radial capacity is the predominant feature, but light or intermittent thrust loads are carried well by some types. Some of these units operate very satisfactorily at high speeds.

JOURNAL ROLLER BEARINGS

Journal roller bearings cover an extremely wide range of basic designs and sizes. They are usually associated with severe radial loads and slow to moderate operating speeds, with running accuracies near those of standard industrial bearings.

Some have metric boundary dimensions; others

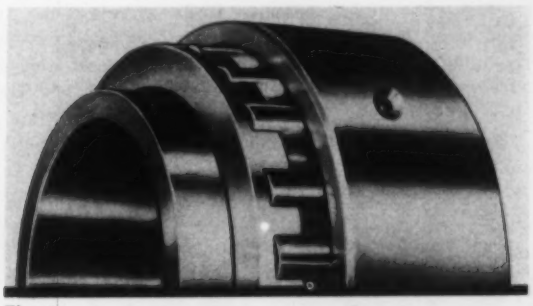


Fig. 21

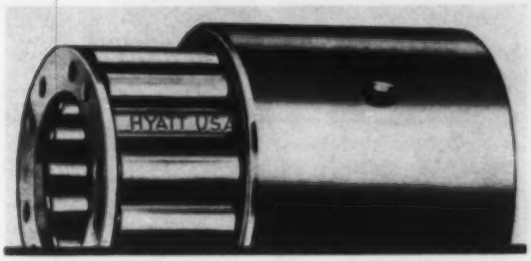


Fig. 22

are based on the inch scale. Many of them are of three-piece, separable construction. They may be used as a complete bearing, Fig. 21, or with one or both races removed, Fig. 22.

Roll size and complement vary widely for a given bearing size. Cage materials, end-ring design, staybar assemblies, and other features may also vary. With space limitations, the journal roller bearings often prove to be the answer, especially if used without one or both of the ring members.

SPLIT ROLLER BEARINGS

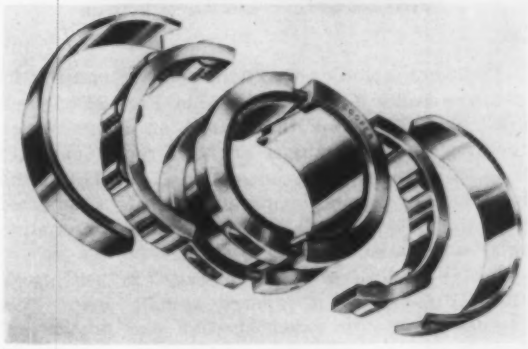


Fig. 23

This type is a regular roller bearing with the whole assembly split right down to the shaft, Fig. 23. A wide range of dimensions and load capacities are available. Modified housing designs include pillow blocks, flange and cartridge units, and hanger bearings. Light to moderate thrust loads are carried by cycloidal contact between the ends of the rolls and the sides of the grooves in the inner and outer races. For applications attended by severe thrust loads, a bearing has been developed which incorporates a standard ball

thrust bearing.

The split roller bearing finds growing use in crushers, flour mills, conveyors, oil-well equipment, cement and textile mills, quarries, collieries, dredges, mining, and other heavy industries. The ease of a change-out enhances its popularity with many operators. The split feature permits dismantling, repair and reassembly to be carried out with speed, while sprockets, sheaves, gears and other heavy accessories remain in position. But it is not limited to such installations. It finds growing acceptance where one-piece bearings have been used.

SPECIAL ROLLER BEARINGS

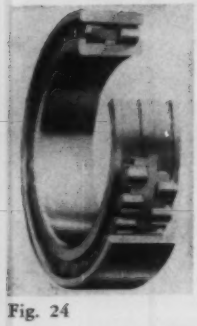


Fig. 24

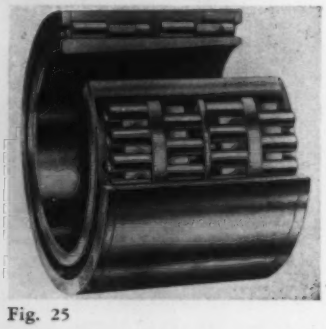


Fig. 25

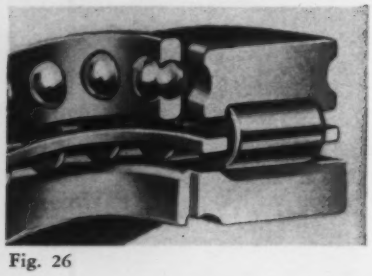


Fig. 26

Precision spindle designers will recognize the two-row roller bearing shown in Fig. 24. Developed exclusively for that range of design which requires the advantages of high radial capacity coupled with rigidity, exceptional accuracy, and minimum operating temperatures, this specialized unit is widely used. It is often used in conjunction with refined ball-bearing designs.

Designed with a tapered bore, the bearing is fitted directly to a tapered spindle seat. This feature allows for exact location and precise adjustment.

Manufacturing specialization is also seen in the multirow cylindrical unit in Fig. 25. Many other special designs are available, such as the one shown in Fig. 26 which incorporates a ball thrust bearing.

ROLLER-BEARING PILLOW BLOCKS

Spherical Roller Units

Utilizing a tapered-bore spherical roller bearing with adapter assembly, Fig. 27, this block with two-piece housing and piston-ring seals is a favorite in industry. The use of stabilizing rings, or their omission, provides for fixed or floating mountings.

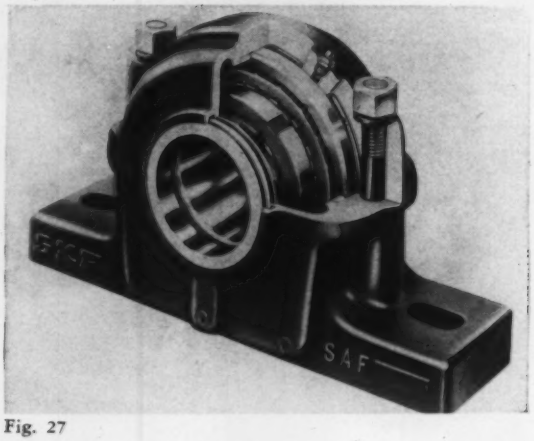


Fig. 27

Basically similar units are also manufactured for direct shaft mounting. For extremely rugged applications, four-bolt housings, of cast iron or steel, are available. Circulating oil systems may be easily applied to the unit. The spherical block is a recognized workhorse of heavy industry.

Spherical All-Steel Block

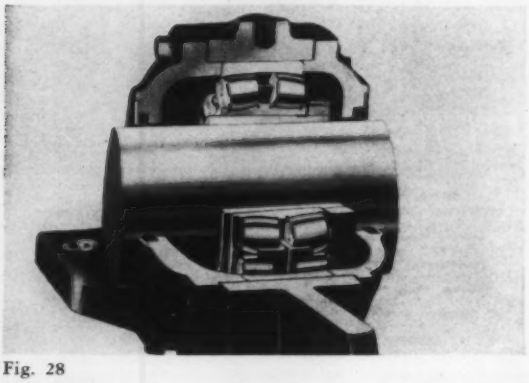


Fig. 28

The spherical roller block shown in Fig. 28 features an all-steel, four-bolt housing. It is manufactured for both tapered bore-adapter and direct seat mounting. Various series of this unit range in size from 2 15/16 to 15 3/4 in., offering a compact, heavy-duty block as often needed on heavy conveyor headshafts, coal-preparation fixtures, mixing tanks, mill motor drives, cement-producing equipment, and other severely loaded mountings.

It may be obtained for fixed or floating mountings, with open or closed end, and with adjustable base plates. The seals are very efficient.

Concavex Bearing Designs

Concave rollers running between convex race-

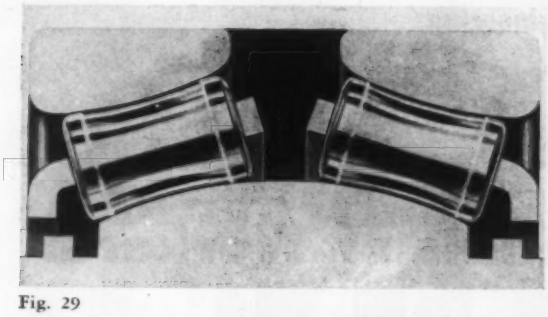


Fig. 29

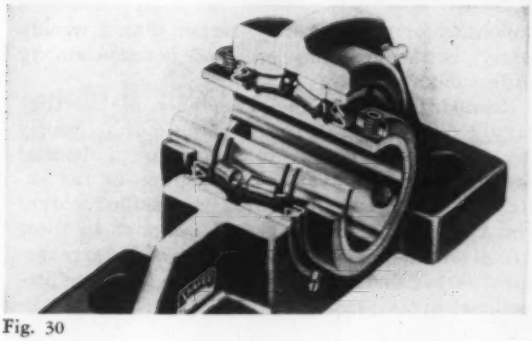


Fig. 30

ways form the basic bearing design shown in Fig. 29. The inner race is a segment of a true sphere, and is free to move in any direction without altering the contact of the rollers. This provides compensation for moderate misalignment, and assures normal and efficient operation. The unit carries radial, thrust or angular loads, and accommodates approximately 3 deg total misalignment.

Modified housing designs incorporating this basic unit include several pillow blocks, one shown in Fig. 30, in normal and heavy-duty construction, and fixed and expansion variations, with auxiliary cap seals (closed end) available in some series. Some blocks are available in both adapter and set-screw mounting. Seals are highly efficient, and the micro-lock adjustment provides 12 points of adjustment in increments of 0.005 in. on small units; of 0.007 in. on units intermediate in size; and of 0.010 in. on the larger designs.

Other housing designs include flange and cartridge units, takeup units with or without frames, and other special designs.

A series of high-capacity aircraft bearings uses this basic bearing design.

Tapered Roller-Bearing Blocks

The typical tapered roller-bearing block shown in Fig. 31 is especially well suited for applications where exposure to dust or other external contamination is unusually severe. The basic design consists of two standard tapered roller-bearing assemblies mounted on a sleeve. The ends of the sleeve are slotted and shaft-mounting is accomplished by clamping these flexible slotted ends tightly to the shaft by means of split clamp collars.

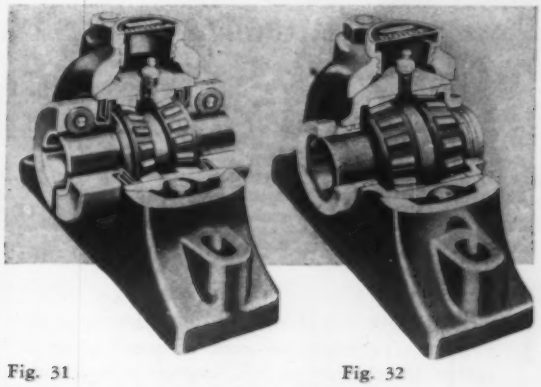


Fig. 31

Fig. 32

The collars also provide a means of adjustment. Labyrinth seals are located between the collars and the bearings. Fixed and floating units are available.

A variation in tapered-block design is shown in Fig. 32. It is particularly suited for high loads. It has a special tapered roller-bearing duplex bearing with a tapered bore; the inner race is carried on a split tapered sleeve which has a cylindrical bore. Expansion and nonexpansion units are available. Highly effective piston-ring seals are used.

PHOTO CREDITS

MACHINE DESIGN acknowledges with appreciation the co-operation of these companies in the preparation of this article:

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Charles A. Colgate Co. (Fig. 28) Pittsburgh, Pa.
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Shafer Bearing Div., Chain Belt Co. (Fig. 29, 30) Downers Grove, Ill.
SKF Industries Inc. (Fig. 16, 17, 24, 25, 27) Philadelphia, Pa.
Timken Roller Bearing Co. (Fig. 1, 3, 4, 5, 6) Canton, O.
Torrington Co. (Fig. 7, 14, 15) Torrington, Conn.

They Say . . .

"Standards as employed by industry should be such that they represent the best commercial practice. They should not be considered as sacred, but should be investigated so that they establish new goals for which to aim."—STANLEY R. JEPSON, *Eitel-McCollough Inc., San Bruno, Calif.*

The Personal Side of Engineering

By **EDWIN C. NEVIS** Personnel Research and Development Corp., Cleveland, Ohio

Professionals or Workers?

IN DISCUSSIONS of the status problems of the engineer, perhaps the most frequent question raised is whether or not engineers are "professional people" or "workers." Confusion is encouraged by the fact that many employers of engineers make little or no distinction between engineers and other employment groups in their employment practices.

Status of a profession is bound up very intimately with two important factors: 1. How the members of the profession are viewed and treated by others. 2. How the members of the profession view themselves in their professional role. Both of these factors are obviously at play at the same time, and it is very difficult to separate them.

If individuals or a group view themselves as being independent, assertive, and of high status or, on the other hand, as lacking in confidence or as being unimportant, people who come into contact with them will tend to accept these views as true evaluations. A professional person is expected to be capable of individual initiative and independent responsibility. So it is perhaps particularly true of professional persons that their status depends in large measure upon the self-conception held by members of their own group. In passing, reference might be made to the effect upon the status of the medical doctor of having very firm, authoritative, and somewhat dogmatic views adhered to and vigorously supported by the organized societies within the medical profession.

In other words, a concept of one's professional role is reflected, among other things, in the job practices adhered to and supported by members of the profession, including attitudes and practices regarding salary, working conditions, unionization, and the like. A review of a few practices found acceptable to some engineers may provide clues to some of the things that engineers support, wittingly or unwittingly, which may have a strong effect upon their status.

For example, engineers can generally be hired on the basis of an hourly pay rate. While this may seem like a relatively insignificant point, it nevertheless is one with a great deal of subtle impact. To accept the hourly rate and to conceive of oneself as being employable on this basis implies a lower status in one's own eyes than typical of people in the professions and those at managerial levels. Engineers should certainly be concerned about being paid adequately for their work. But a monthly or yearly salary, rather than a weekly salary, is the generally accepted practice among professional groups.

Related to this is the acceptance of overtime pay. Even more than the acceptance of an hourly pay rate, a willingness to accept or to demand pay for overtime creates a conception of the engineer as similar to the skilled or unskilled worker who typically is employed and bargains in these terms. An increased basic salary or bonus arrangement, rather than hourly overtime, is the more professional arrangement.

Another job practice which influences status, and which seems to reflect some insecurity in the view engineers have of themselves and their chances for professional success, is a tendency to accept and welcome seniority as a basis for pay raises and promotion. Traditionally, professional recognition is an individual matter, with personal contribution the key factor in determining the reputation and value of an individual.

Seniority as a basis for advancement creates the impression that one is more concerned with one's pay check and "daily comfort" than with the opportunity to accept challenge and responsibility. It is interesting to note that the professional engineering unions, unlike typical labor unions, tend to include merit review procedures in their bargaining concerns. With these procedures, companies periodically evaluate the performance of engineers and grant pay raises and promotions on the basis of merit rather than upon seniority. This is in line with sound psychology of professionalism. It is an attempt to demonstrate to employers that engineers are willing to be judged on their contribution. It also establishes engineers as being confident that, given the opportunity to show what they can do, they will be able to earn rewards in proportion to their contribution.

In effect, each individual must ask whether or not his cause as a professional person is injured when he adopts practices which are common among groups of lesser status, even though these practices may seem more desirable in terms of current values. This question must be asked even in the face of a very real concern of the engineer with the fact that skilled mechanical and technical workers very often make as much or more money. Engineers should certainly seek to improve their earnings. But, to maintain their professional status, they should seek professional ways of doing so.

Calculating force relationships in

Converting Linear to Rotary Motion

By DENNIS P. HANLEY
Instructor, Mechanical Engineering Dept.
University of Maryland
College Park, Md.

While geometrically straightforward, linkages for converting linear to rotary motion give rise to complex relationships between force, displacement, and time. As shown here, solution for such factors can be facilitated through analytical techniques that provide a basis for selecting linear actuators for rotational applications.

TORQUE required to rotate a given mass at constant acceleration is given by the product of its polar moment of inertia and angular acceleration, or

$$T = I\alpha$$

If the design situation permits, a rotary solenoid with a fairly flat torque-displacement curve will supply the required constant torque. However, where a linear actuator with a flat force-displacement characteristic—such as an air piston or reciprocating solenoid—is used to provide rotation, Fig. 1, constant torque cannot be developed because of the changing direction of the actuator-force moment arm. This article demonstrates how a linear component may be selected on the basis of this varying torque.

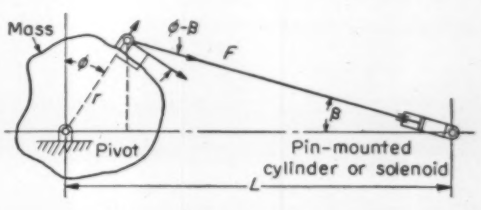


Fig. 1 — Typical linkage employing a linear actuator to rotate a mass.

Torque vs. Displacement: In a typical linkage arrangement, Fig. 1, the linear actuator is clevis-mounted and the connecting rod is pinned to some point on the body. The following assumptions allow the linkage analysis to be simplified:

1. Force F exerted by the linear actuator is constant.
2. If the mass rotates in the vertical plane, the pivot point is at the mass center of gravity. If the mass is horizontal, the pivot can be at any point.
3. Weights and moments of inertia of connecting rod and linear component are small compared to those of the body.
4. Ratio $L/r = n > 1$.
5. Initial angular displacement and angular velocity are zero when t equals 0.

From Fig. 1, instantaneous torque T on the body at angle ϕ is given by the relationship,

Nomenclature

F	= Linear force, lb
I	= Polar moment of inertia of mass about axis of rotation, lb-in.-sec^2
L	= Center-to-center distance between pivot of mass and pivot of actuator, in.
n	= L/r ratio
r	= Distance from mass pivot to point of attachment of connecting rod, in.
T	= Torque, lb-in.
t	= Time, sec
α	= Angular acceleration, rad per sec^2
β	= Angle between connecting rod and line of centers, rad
ϕ	= Angular displacement, rad
Φ	= Final angular displacement, rad
ω	= Angular velocity, rad per sec

$$T = Fr \cos (\phi - \beta) \tag{1}$$

From geometry of the linkage,

$$\beta = \tan^{-1} \left(\frac{\cos \phi}{n - \sin \phi} \right) \tag{2}$$

Substituting Equation 2 in Equation 1 and expanding by trigonometric relations,

$$T = Fr \left(\frac{n \cos \phi}{\sqrt{n^2 - (2n \sin \phi) + 1}} \right) \tag{3}$$

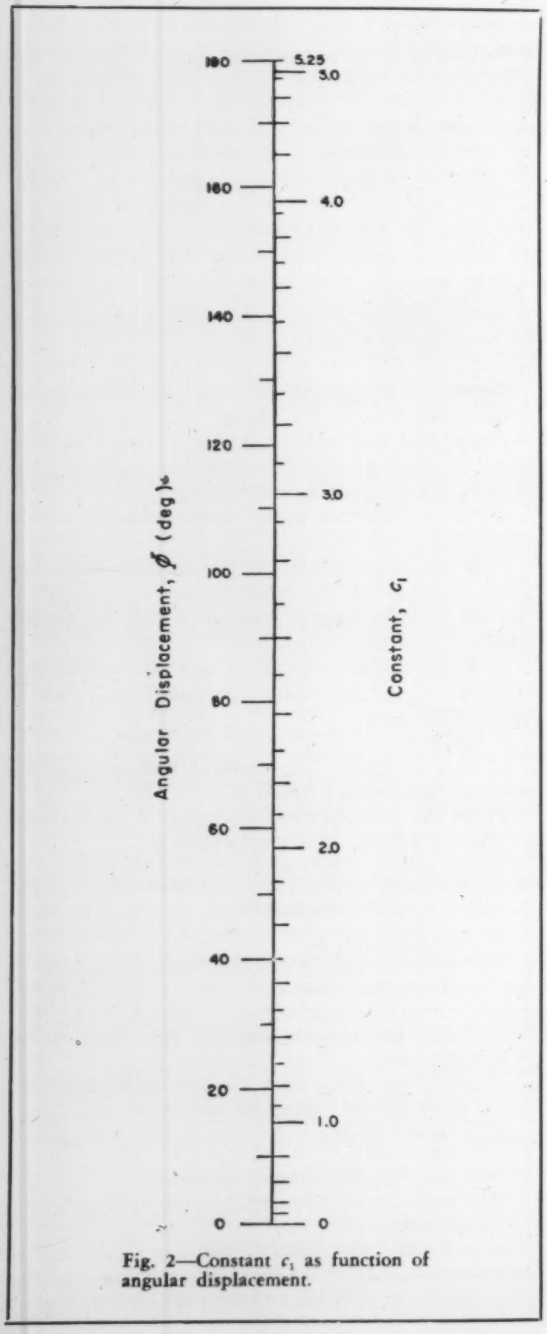


Fig. 2—Constant c_1 as function of angular displacement.

Since $T = I\alpha$, this may be expressed as

$$\alpha = \frac{Fr}{I} \left(\frac{n \cos \phi}{\sqrt{n^2 - (2n \sin \phi) + 1}} \right) \tag{4}$$

By substituting the relation

$$\alpha = \omega \left(\frac{d\omega}{d\phi} \right)$$

Equation 4 can be integrated to give

$$\omega = \frac{d\phi}{dt} = \sqrt{\frac{2Fr}{I}} \left[\sqrt{n^2 + 1} - \sqrt{n^2 - (2n \sin \phi + 1} \right]^{1/2} \tag{5}$$

Integrating again to obtain t as a function of ϕ,

$$t = \sqrt{\frac{I}{2Fr \sqrt{n^2 + 1}}} \int_0^{\phi} \frac{d\phi}{\sqrt{1 - \sqrt{1 - k \sin \phi}}} \tag{6}$$

where

$$k = \frac{2n}{n^2 + 1}$$

Since n was assumed greater than 1, k must be fairly small, and $k(\sin \phi)$ is even smaller. Thus, the following binomial expansion can be employed:

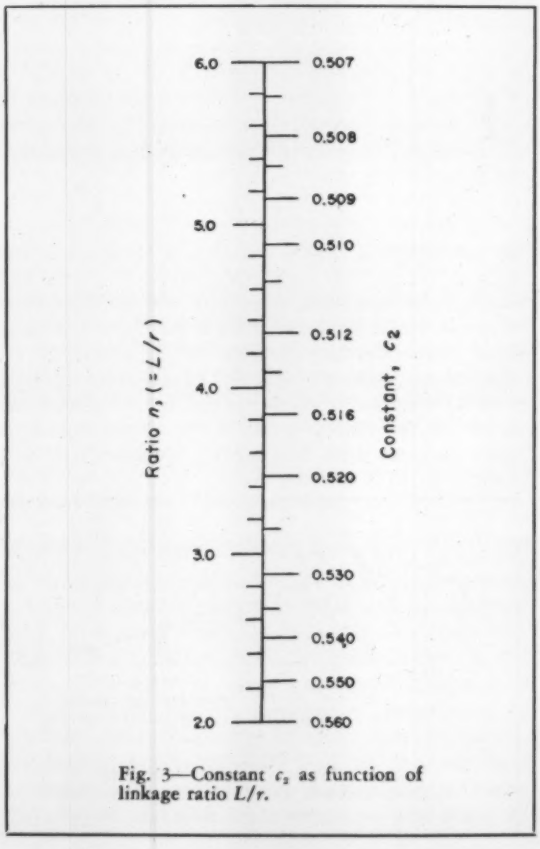


Fig. 3—Constant c_2 as function of linkage ratio L/r.

$$\sqrt{1 - k \sin \phi} = 1 - \frac{k \sin \phi}{2} - \frac{k^2 \sin^2 \phi}{8} - \ldots$$

Use of the first two series terms reduces the complexity of the integral in Equation 6 considerably, giving

$$t = \sqrt{\frac{I\sqrt{n^2+1}}{2Frn}} \int_0^{\phi} \frac{d\phi}{\sqrt{\sin \phi}} \qquad (7)$$

The integral in Equation 7, which is an elliptic integral in Jacobian form, is hereafter designated c_1, or

$$c_1 = \int_0^{\phi} \frac{d\phi}{\sqrt{\sin \phi}}$$

Values for c_1, taken from a handbook of elliptic integrals, are plotted in Fig. 2. Further simplification can be effected by defining

$$c_2 = \frac{\sqrt{n^2+1}}{2n}$$

Values of c_2 are plotted as functions of n in Fig. 3. Writing Equation 7 with c_1 and c_2 and solving for the required force,

$$F = c_1^2 c_2 \left(\frac{I}{rt^2} \right) \qquad (8)$$

Example: Select a 50-psi air piston which can rotate a mass of weight 13.77 lb and moment of inertia 0.4534 lb-in.-sec^2 through 180 deg in 60 milliseconds starting from rest ($\phi = 0$). Stroke of the piston will be such that it pulls from 0 to 90 deg and pushes from 90 to 180 deg. The cycle then reverses so that the mass continually oscillates through 180 deg. Assume from practical design considerations that $n = 4$ and $r = 5$ in. The mass is to be rotated in the vertical plane with the pivot through the center of gravity, and ends of the stroke are cushioned.

Because of obvious symmetry, calculations are made only for the first 90 deg of travel. From Fig. 2, for $\phi = 90$ deg, $c_1 = 2.6$. From Fig. 3, for $n = 4$, $c_2 = 0.515$. Thus, from Equation 8, force required to rotate the mass is

$$F = (2.6)^2(0.515)\left(\frac{0.4534}{5(0.03)^2} \right)$$

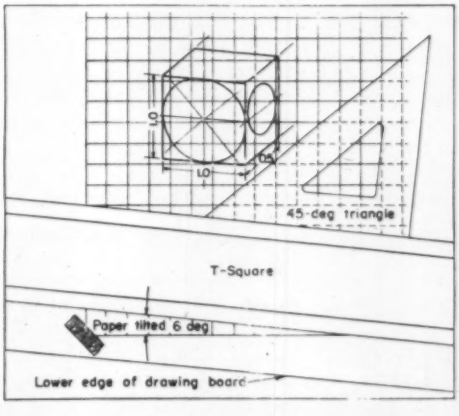
$$= 356 \text{ lb}$$

Hence, exact solution to the example problem is given by an air piston with an area of 7.12 sq in. From practical considerations, a 3-in. diam cylinder with area of 7.08 sq in. might be selected. The pressure, of course, can be varied slightly to accommodate any discrepancy in actuation time due to factors such as the inertia of the rod and piston, both of which were assumed negligible in the analysis.

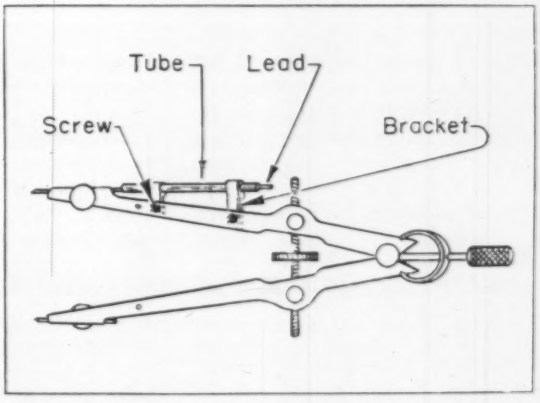
Tips and Techniques

Dimetric Projection

With an ordinary T-square and a 45-deg triangle, a dimetric drawing can be made that is sufficiently accurate for most applications. The tracing paper is mounted over cross-section paper and both papers are tilted 6 deg. The vertical lines on the cross-section paper are used as a guide for one axis. The other two axes are drawn with the T-square and the 45-deg triangle, as shown. Ellipses of 60 and 20 deg are used.—THOMAS D. REID, *engineering draftsman, Aeronautical Communications Equipment Inc., Miami, Fla.*



Protecting Compass Lead



A longer piece of lead may be used in a compass if the lead is protected. The protective device can be easily constructed from an empty ball-point pen refill or a similar piece of tubing. Short sheet-metal brackets hold the tubing in place.—JOSEPH KANTROWITZ, *Daven Co., Livingston, N. J.*

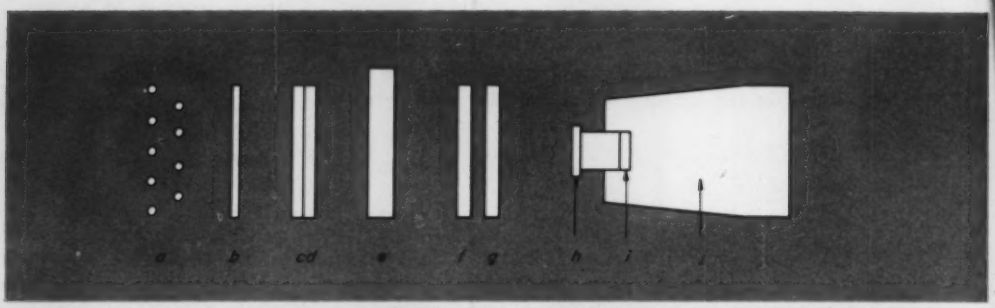


Fig. 1—Simple diffusion-polariscope. Components include light source, *a;* flashed opal glass diffusion-screen, *b;* Polaroid discs, *c* and *g;* quarter-wave plate discs, *d* and *f;* frozen-stress slice, *e;* camera lens, *h;* filter, *i;* and camera, *j*.

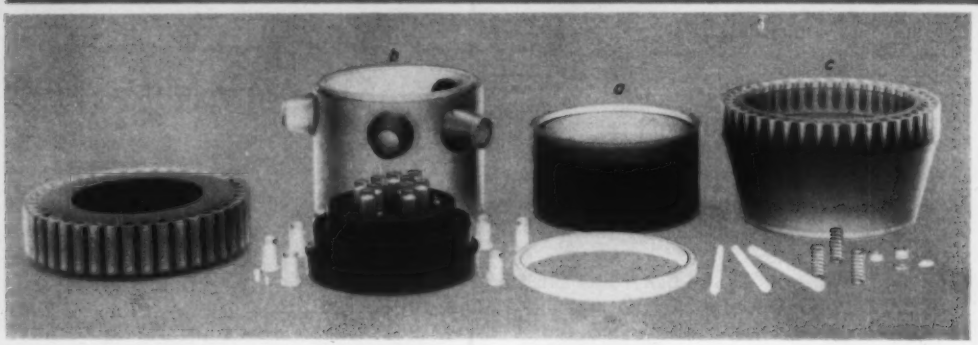


Fig. 2—Photoelastic model of a pressure vessel before assembly. Parts *a, b,* and *c* were machined from epoxy resin. Cores taken from the solid castings were used to form various small parts of the assembly. Epoxies are excellent model materials because of their high figure-of-merit values.

Three-Dimensional Photoelasticity

By M. M. LEVEN and A. M. WAHL
Westinghouse Research Laboratories
Westinghouse Electric Corp.
Pittsburgh, Pa.

THE "frozen-stress" method for three-dimensional photoelastic stress analysis is a simple but effective technique for performing practical photoelastic tests on complicated structures. Results, based on purely elastic conditions, are used in design applications where fatigue, repeated strain-cycling, plastic flow, and creep-rupture effects may occur.

In this method, a model of the structure is heated to a certain temperature known as the critical temperature, loaded, and then slowly cooled with loads acting. At room temperature, loads are removed but strains are fixed, or "locked," in the model. Careful cutting or slicing will not disturb these strains which represent an elastic distribution of stress.

Equipment: In addition to model machining and darkroom facilities, and a suitable oven for model loading, it is necessary to have only a simple diffusion-polariscope, Fig. 1, to engage in practical three-dimensional photoelastic work. The outstanding feature of such a polariscope is that it contains only one lens, the camera lens. The polariscope is very simple to align and, in addition, light intensity is very high and patterns are visible even in a lighted room.

Light source *a*, Fig. 1, can contain both green and white fluorescent lamps so that, by suitable switching, the light can be changed from white to monochromatic. Polarizer *c*, analyzer *g*, and quarter-wave plates *d* and *f* are relatively inexpensive and readily obtainable. Lens *h* is the most expensive part of the apparatus. The longer the focal length of this lens, the more accurate the polariscope. A focal length of about 19 in. is recommended, although satisfactory results are obtained with a focal length as short as 7.5 in. Elements *c, d, f,* and *g* should rest in rotatable mounts with facilities for easy insertion and removal of quarter-wave plates.

Model Materials: The best material available for models for three-

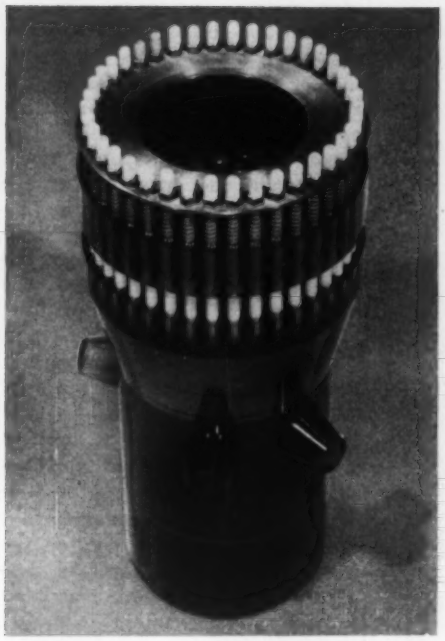


Fig. 3—Assembled pressure vessel prior to testing. Major parts of the vessel are cemented together with a room-temperature-setting resin adhesive.

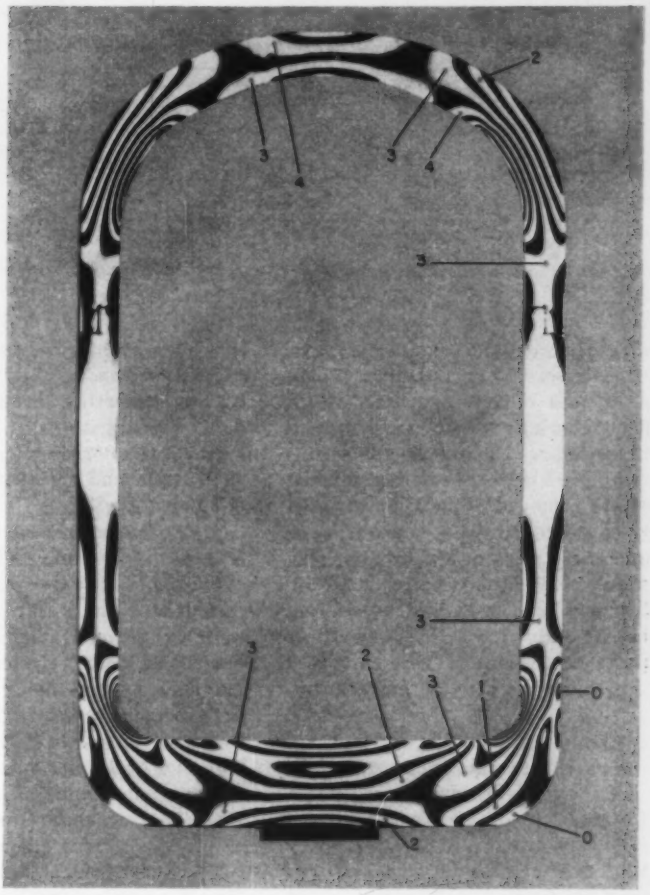


Fig. 4—Stress pattern obtained with normal incidence of polarized light on a meridian slice cut from a 6-in. diam pressure vessel. Thickness of slice is 0.250 in. Numerals on the stress pattern denote fringe orders from which meridian stresses on the outer surface are obtained when multiplied by fringe value.

Three-dimensional photoelastic tests on complicated structures yield results which are directly applicable to machine design. Described here are techniques, equipment, and materials required to obtain these results by the frozen-stress method.

dimensional frozen-stress tests is phthalic anhydride - cured epoxy resin. One of the most important properties which model material must possess is a high figure of merit. Figure of merit is defined as $Q = E/f$, where E is modulus of elasticity and f is material fringe value in psi/fringe/in. at the elevated temperature at which stresses are frozen. Thus Q is a relative measure of the number of fringes of retardation produced by a unit strain. A high figure of merit is required in order to limit deformations and deflections in the model to an order of magnitude comparable to that in the metal prototype. Table 1 shows the figure of merit of some plastics compared with a typical epoxy resin. Frozen-stress properties for epoxies vary with varying phthalic-anhydride content. However, ease of casting, tensile strength, and residual casting stresses influence the figure of merit somewhat.

Epoxy resins are suitable for models not only because of their high figure of merit, but because they can be cast readily in large sizes and meet all other requirements of a good photoelastic material. Because of their high adhesive qualities, epoxy parts can be cemented together to simulate welded structures. Epoxy-resin coatings are also suitable for measuring surface strains on metal parts in both the elastic and plastic ranges. Epoxy coating is sprayed or brushed directly on the polished metal surface or on a reflecting undercoating applied to the metal. When polarized light is passed through the coating and reflected back, the photoelastic effect measures strains on the surface of the metal part due to applied loads. Thin sheets of epoxy may also be cemented to the metal surface to form the coating.

Casting, Cementing, and Machining: Epoxy resins can be cast in any size or shape with a very minimum of experience and instruction. Cast cylinders of limited sizes are also available commercially. Fig. 2 shows various parts

Table 1—Frozen-Stress Properties of Model Materials

Material	Critical Temperature (C)	Modulus of Elasticity, E (psi)	Material Fringe Value, f (psi/fringe/in.)	Figure of Merit, Q (E/f)
Trolon	80	1250	3.0	415
Bakelite	120	1200	3.3	365
Epoxy	165	5150	2.3	2235

of a photoelastic model of a pressure vessel before assembly. Parts *a*, *b*, and *c* were machined from solid castings which were formed in ordinary 10 and 15-gal aluminum cooking tubs with handle rivets removed. The solid castings were cored to make vessel parts, and cores were used to make caps, nozzles, and other small parts. Fig. 3 shows the assembled vessel and head ready for test. The three parts of the vessel were cemented together with a room-temperature-setting resin.

Epoxy resins have very high abrasive effects on cutting tools and quickly dull ordinary tool steels. Carbide-tipped tools should be used in all machining processes. Very high cutting speeds with low feed speeds are required to prevent chipping at the edges. Threads should be chased whenever possible. If taps or dies must be used, it is desirable to obtain special ones which perform the operation in gradual steps. Frozen-stress slices can be rough cut on a band saw and finished to required thickness by fly-cutting, i.e., single-point cutting. Hand scraping or careful grinding also may be used, and is especially useful in preparation of curved-surface slices. In general, fly-cutting is preferred to milling. It is desirable to test every machining operation on a sample piece of material.

Selection of Slices: Slicing the photoelastic model should be done so that required information can be obtained using normal incidence of polarized light. This means that slices should be made along known principal planes such as planes of symmetry or free surfaces. Separation of stresses likewise should be effected from additional slices or subslices using, again, normal incidence. While considerable simplification can be obtained in slicing by resorting to oblique-incidence investigations, it is felt that considerable error can result in such tests, and the saving in time is not justified.

Fig. 4 shows the stress pattern of a meridian slice removed from a cylindrical pressure vessel with a toroidal top and a flat bottom. Due to the rotational symmetry of the vessel and loading system, a meridian slice is a plane of symmetry or a principal plane. The normal incidence stress pattern in Fig. 4 will thus yield meridian stress, σ_m, on the inner and outer surfaces, since the circumferential or hoop stresses, σ_θ, have the same direction as the incident light and will, therefore, have no influence on stress pattern.

Thus, if n_o and n_i are fringe orders along the outer and inner surfaces, respectively, then

$$\frac{\sigma_m}{p} = \frac{n_o f}{tp} \qquad (1)$$

on the outer surface, and

$$\frac{\sigma_m}{p} = \frac{n_i f}{tp} - 1 \qquad (2)$$

on the inner surface where t is the thickness of the slice, and p is the numerical value of applied internal pressure in the vessel.

Dimensionless stresses obtained by Equations 1 and 2 are shown by solid curves in Fig. 5. The open circles are values of meridian stress on the outer surface obtained from a strain-gage test made independently on a steel vessel. The remarkable agreement with photoelastic results demonstrates the validity of the frozen-stress method.

Circumferential stresses σ_θ were determined over the cylindrical portion of the vessel with transverse slices, such as slice *a*, Fig. 6, with normal incidence. On the toroidal and filleted portion of the vessel, σ_θ was obtained with surface or skin slices such as slice *b*. Fringe-order determination using normal incidence on the latter slices is a point-by-point procedure along the curvature of the subslice as shown in Fig. 6. Attention is directed to the continuity of the fringes through the cemented joint as shown in the stress pattern, Fig. 4.

Fringe - Order Determination: Fringe orders, in general, are of lower magnitude than those of two-dimensional tests. This is especially true with surface slices or subslices where thickness of the slice must be kept to a minimum so that the average stress is not too far from the surface. Therefore, it is important to measure fractional fringe-orders rapidly and accurately.

With polarizer and analyzer crossed (monochromatic light and a standard circular polariscope) and coinciding with principal stress directions at a point, the analyzer is rotated through an angle ϕ until extinction occurs at the point in question. Then

$$n = r + \frac{\phi}{180} \qquad (3)$$

where r is the order of the last visible fringe. For extinction obtained by rotation in the opposite direction, Equation 3 becomes

$$n = (r + 1) - \frac{\phi}{180} \qquad (4)$$

Directions of rotation for which Equations 3 and 4 apply must be determined from experiment or experience with a given polariscope and slice. White-light examination of the stress pattern and approximate compensation with slices into which known stresses have been frozen are quite useful for the determination of r and for deciding which of the equations applies. An error of ± 20 degrees in alignment of the polariscope elements with respect to principal stresses results in an error in ϕ of less than ± 6 degrees or less than 1/30 of a fringe.

Fig. 7 shows another stress pattern obtained from a slice removed from the center of a long bar of

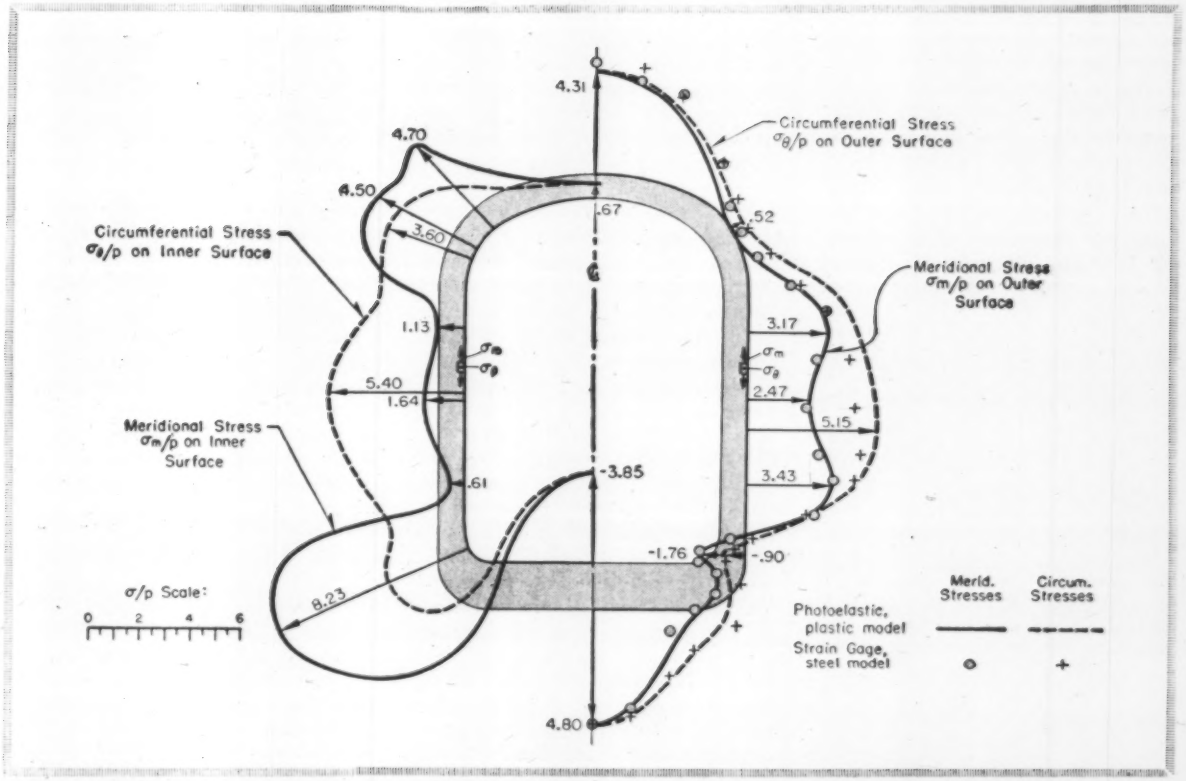


Fig. 5—Dimensionless stress on surfaces of 6-in. diam pressure vessel model obtained from photoelastic and strain-gage tests. Minus sign denotes compression. Close agreement of results of both methods indicates accuracy of the frozen-stress method.

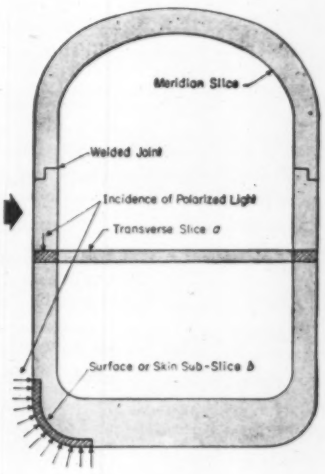


Fig. 6 — Meridian and transverse slices, and surfaces subslice of pressure vessel. Note position of "welded" joint and continuity of fringes through the joint, Fig. 4.

Fig. 7—Stress pattern of central transverse slice cut from a bar of rectangular cross section containing three pressurized holes. Numerals denote fringe orders. Thickness of slice is 0.300 in.

rectangular cross section containing three pressurized holes. Fractional fringe orders indicated on the pattern were determined by Tardy compensation, and dimensionless stresses were again obtained from Equations 1 and 2.

Interior Stresses: The preceding example illustrates a method for determining stresses on free

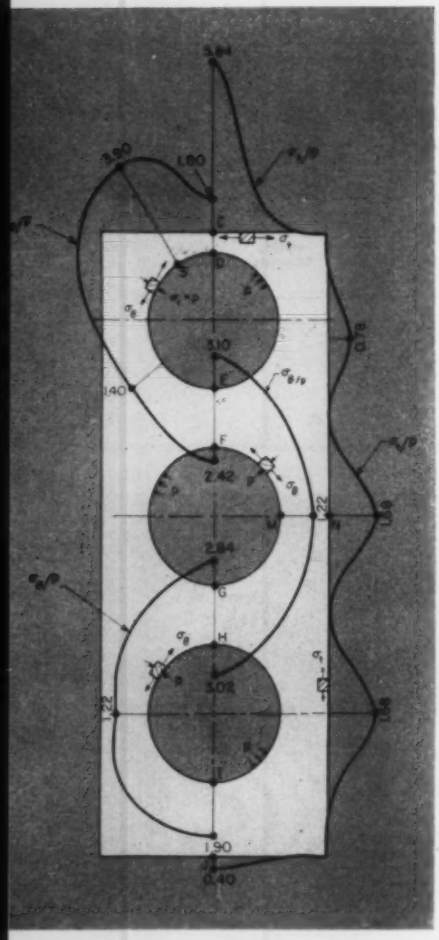


Fig. 8—Circumferential and tangential stresses on inner and outer surfaces respectively. Stresses are result of internal pressure, p, of the holes.

surfaces where the stress system is biaxial, or on pressurized internal surfaces where direction and magnitude of the third principal stress (pressure) is known. Photoelastic methods have been developed for determination of stresses for the general case of triaxial stress which exists on loaded surfaces or at interior points. However, these methods are extremely cumbersome and lead to very inaccurate results unless performed with extreme care and skill. In general, interior stresses are not of great significance in practical design problems.

Application of Results to Practical Design: Generally, it is considered that photoelastic results are most applicable to cases where fatigue or repeated loading is present. The latter loading may be for a large or for a relatively small number of cycles. In addition, however, photoelastic results have been found useful in estimating reduction in creep-rupture life for machine parts or structures subject to long-continued stress at elevated temperatures.

Peak stresses obtained by photoelastic means usually refer to some point of stress concentration as, for example, near an opening or nozzle in a pressure vessel. For ductile materials, the peak stress near such points of stress concentration under operating conditions generally will not exceed yield stress. Assuming a load or pressure range between a maximum and minimum load, it is considered that photoelastic results usually give the stress range between such loads, the stress at maximum load being taken as yield stress. This is approximately true provided that the stress range is less than twice the yield stress. For elastic stress ranges greater than this, photoelastic results may still be used to estimate strain ranges at points of strain concentration, which are of primary importance where relatively few cycles of loading are involved.

Fatigue or Repeated Strain-Cycling: Where a machine part or structure is subject to a large number of cycles of repeated loading, design methods may be used which are based on determination of fatigue-strength reduction factors in cases where stress concentration is present (fillets, grooves, holes, etc.). In most cases, however, stress-concentration factors obtained by photoelastic means are quite close to fatigue-strength reduction values and, therefore, may be used for conservative design purposes, particularly for fillet or groove sizes normally encountered in practice. In cases where a large number of cycles of combined steady and alternating stress is involved, Fig. 8, where stress concentration is present, the most common practice appears to be to neglect stress-concentration effects when calculating mean or steady component of the stress, but to include such effects in calculating the alternating component.

Methods also are given for calculating factors of safety for notched bars under repeated bending, torsion, or tensile loading for a limited number of stress cycles. These methods are based on the assumption of a linear relation between S and log N. Also, it is again assumed that stress concentration may be neglected in calculating steady-stress component, for cases of combined steady and alternating stress.

An alternative method of treating this problem is to calculate both the steady and alternating-stress components, taking into account stress concentration and assuming elastic conditions. It is then assumed that the peak stress will not exceed yield stress, while the mean stress is reduced by the amount which the theoretical peak stress exceeds yield stress.

However, since mean stress cannot be reduced below zero, if the alternating-stress component is above yield stress, mean stress is taken as zero. This method is probably more commonly used for pressure-vessel design, for example, where openings and discontinuities of relatively large size are present.

Photoelastic results have proved useful in making estimates of the reduction in creep-rupture life for parts having holes, notches, or fillets and subject to creep at elevated temperature, and for materials showing limited ductility in creep-rupture tests of smooth bars.

For such materials which are referred to as "notch sensitive," creep-rupture life is much less than that for smooth bars, except for very short lives.

From a paper entitled "Three-Dimensional Photoelasticity and Its Application in Machine Design," presented at the ASME Annual Meeting in New York, December, 1957.

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Circle 490 on Page 19

High-temperature characteristics and Wear resistance of

Antifriction-Bearing Materials

By T. W. BAKEWELL
New Departure Div.
General Motors Corp.
Bristol, Conn.

MODIFIED high-carbon chrome bearing steels exhibit a reduction in hardness, and oxidation and dimensional change, when operated at elevated temperatures for extended periods. A decrease to approximately 54.4 from Rockwell C 64 occurs after 3000 hr at 600 F. Although reduced hardness may not be detrimental under light loads, dimension changes can be significant. For this reason, it is standard practice to temper the materials at approximately 50 F above expected operating temperature.

High-carbon chrome steels are not usually recommended for operation above 400 to 450 F. Stainless steel, 440C, hardened initially to Rockwell C 62 or 64, holds at 58 when exposed at about 900 F. An initial hardness of Rockwell C 58 drops to approximately 52 after 10,000 hr at 700 F. The stainless properties of 440C, however, are destroyed after heating above 705 F.

High-speed tool steels retain initial hardness generally within two points up to 500 or 600 F. It is the usual practice to specify a room hardness of Rockwell C 59 to 61 for an average of 58 at 600 F. Commercial grades of both 440C and various tool steels contain excessive amounts of nonmetallic inclusions. Various grades of tungsten and chrome carbides show definite promise for extreme high-temperature bearing applications but present high cost of these materials has limited their use.

Wear-Resistant Materials: Separator wear, occurring over contact surfaces, is the result of sliding friction at appreciable velocities. Although cotton-bonded phenolic separator stock has superior wear resistance under conditions of scant lubrication, it begins to char and lose strength above 225 F. Silver plate is extremely effective to 350 F, at which point transfer to the balls occurs. S Monel has a fairly consistent rating to 1000 F, but leaded bronze and iron-silicon bronze have better ratings at the lower temperatures. Also, iron-silicon bronze is superior in the 500 to 600 F range.

Sintered materials, either oil or dry-lubricant impregnated, offer attractive prospects for lightly loaded bearings at moderate speeds. Tests with oil, graphite, and Teflon-impregnated sintered bronze show that the poor tensile strength and nonhomogeneous structure limits available materials to low-speed applications.

Teflon, either filled for added resistance to flow or as a coating for metallic separators, gives excellent results with scant lubrication. By itself, it has little resistance to flow and creep but with the proper filler its resistance to flow is increased. However, high coefficient of thermal expansion imposes certain design restrictions and adds to the difficulty of obtaining a good bond to metals.

Design Factors: Attempts to minimize bearing wear by selecting materials most compatible for operating conditions will not be effective unless combined with certain design practices. Provision must be made in the bearing design to exhaust as nearly as possible products of wear to prevent their "locking" the bearing. Generous clearances over nonguiding surfaces have been found effective and also reduce separator inertia. However, care must be taken that strength is not sacrificed.

Occurrence of wear naturally increases internal clearances within the bearing. Preloading springs which apply a light thrust load are effective in compensating for wear by maintaining positive contact of balls with races.

From a paper entitled "Mechanical Factors Involved In Bearing Design For Aircraft Electric Motors," presented at the SAE Annual Meeting in Detroit, Michigan, January, 1958.

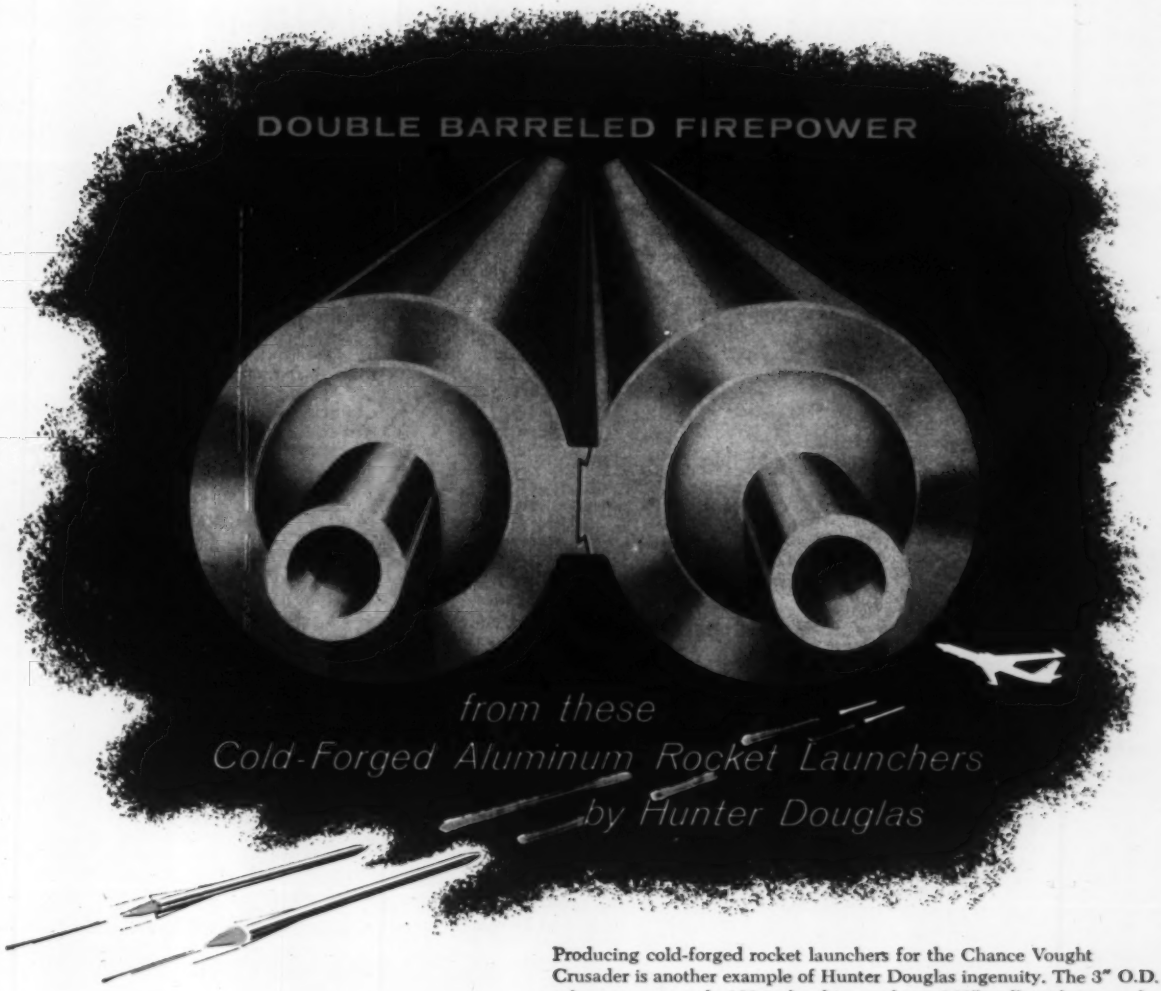
Polyethylene as a High-Voltage Insulator

ONE of the most promising materials for high-voltage insulation is polyethylene. It has been accepted by the Insulated Power Cable Engineers' Assoc. for 5000-v circuits, and present ratings extend to 15,000 v.

The following conclusions are based on tests which evaluated ac voltage vs life characteristics of conventional and high molecular weight polyethylene. Conductors were single No. 9 AWG solid (not tinned) copper with insulation thicknesses of 0.1 in.

1. High molecular weight polyethylene can be expected to have a voltage life of approximately seven times that of standard polyethylene.
2. For any type of base polymer, contamination of the polyethylene by dirt impregnation shortens voltage life appreciably.
3. Addition of carbon black to high molecular weight polyethylene reduces voltage life to a value of approximately that of standard polyethylene.
4. Addition of 5 per cent butyl rubber has no significant effect on voltage life of polyethylene.
5. Presence of voids reduces initial step-rise strength of polyethylene as compared to its quick-rise strength. This effect may not shorten voltage life if moisture is permitted to penetrate voids.
6. Extrapolation of voltage-life curves indicates that high molecular weight polyethylene may last (to 50 per cent failure) more than 40 yr in water at operating stresses to 45 v per mil.

From a paper entitled "Dielectric Strength and Voltage Life of Polyethylene," presented at the AIEE Winter General Meeting in New York, February, 1958, by G. H. Hunt, M. J. Koulopoulos, and P. H. Ware, Simplex Wire & Cable Co., Cambridge, Mass.

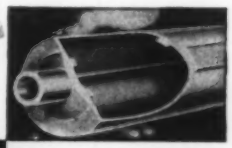


Producing cold-forged rocket launchers for the Chance Vought Crusader is another example of Hunter Douglas ingenuity. The 3" O.D. tube, approximately 100 inches long with an .046" wall, with one end closed, required a fantastic arrangement of internal and external longitudinal ribs, almost impossible to fabricate by conventional methods.

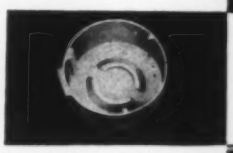
Even cold forging with its ability to integrally form complex part geometry, was put to rigorous tests. For example, cross sections of the tubes were non-symmetrical, generally a serious taboo in cold forging techniques. Further, the non-symmetrical design aggravated longitudinal bow, yet tubes had to be straight within .120" overall. Finally, retention of a minimum wall adjacent to the heavy section presented the problem of uniform metal flow. The heat treated tubes must withstand 1400 psi hydrostatic pressure without deformation.

By combining the varied talents of an experienced engineering staff, good tooling design and sound production techniques, the *cold forged rocket launcher is a fact today*... assembled from two cold forged tubes mechanically joined by a dovetail. Simpler and lighter in design, the cold forged launchers are built to closer tolerances, with greater strength *at less cost!*

If your components can be cold forged, Hunter Douglas can do it! For recommendations, submit your prints or samples.



Section is removed to show internal detail of closed end.



An end sawed from the full length tube illustrates internal and external ribs as well as end detail.

Joining the twin barrels was solved by a dovetailing operation. The wide external rib seen in Fig. 2 provides dovetail area.

Overall tube length is indicated here. Entire unit is one piece. Dovetailing is the only assembly operation required.

Hunter Douglas Aluminum

Division of Bridgeport Brass Company

Dept. MD-3, Riverside, California • OVerland 3-3030

Helpful Literature
for Design Executives

For copies of any literature listed, circle Item Number on Yellow Card — page 19

Electronic Components

More that 390 stock and special application audio transformers, chokes, filters, geophysical and high temperature transformers, reactors, magnetic amplifiers, miniature and pulse transformers, toroids, and audio units as well as other electronic components are detailed in Catalog 102. 28 pages. Hermetic Seal Transformer Co., 555 N. Fifth St., Garland, Texas. I

Circle 601 on Page 19

Electrical Insulation

Properties and performance data, as well as uses for isocyanate electrical insulation for continuous operating temperatures of 150° C are covered in illustrated bulletin. 8 pages. Natvar Corp., Randolph Ave., Woodbridge, N. J. D

Circle 602 on Page 19

Trailer Cables

Brief descriptions of applications and sizes available, as well as engineering specifications of various trailer wires and cables are given in bulletin. Items covered include Motoprene wire, thermoplastic, rubber-covered cord, and brake cables. 2 pages. Essex Wire Corp., Dept. A, 1601 Wall St., Ft. Wayne, Ind. J

Circle 603 on Page 19

Blind Rivets & Driving Tools

Catalog 8-416 describes Huckbolt fasteners, blind rivets, and driving tools for comercial and industrial use. Driving tools include manual, pneumatic, and hydraulic types. 12 pages. Huck Mfg. Co., 2480 Bellevue Ave., Detroit 7, Mich. H

Circle 604 on Page 19

Colloidal Graphite Dispersions

Revised Bulletin "'dag' Dispersions for Industry" lists colloidal and semi-colloidal dispersions of graphite, molybdenum disulfide, mica, vermiculite, iron oxide, acetylene black, and copper. Five new dispersions have been added to company's product list. 4 pages. Acheson Colloids Co., Port Huron, Mich. H

Circle 605 on Page 19

Silicone Dielectric Materials

Brochure outlines the properties of "Silicones as Dielectrics." It also discusses use of silicone rubbers, fluids, resins, and compounds in uses ranging from electric motor insulation to intricate electronic control systems. 12 pages. Dow Corning Corp., Midland, Mich. H

Circle 606 on Page 19

Terminal Reference Aids

A wall chart showing 96 different turret terminals laid out by type and a reference catalog of terminals and electronic hardware comprise available terminal reference aids. They provide design and production men quick, accurate guidance to all standard terminals. 40 pages. Precision Metal Products Co., Stoneham 80, Mass. B

Circle 607 on Page 19

Analog Computer

Details of a new model 3100 high accuracy, medium size, analog computer for solving design, analysis, or control problems are covered in Data File 310. 8 pages. Donner Scientific Co., Concord, Calif. M

Circle 608 on Page 19

Rod End Bearings

Catalog No. 58 contains dimensions, descriptions, and design information on a complete line of Alinabal standard, high angle, and other rod end bearings. They have oil-impregnated sintered bronze balls, and are offered in male and female types. Also detailed are spherical bearings, linkages, and ball joint assemblies. 8 pages. Carter Engineering Co., Ferrysburg, Mich. H

Circle 609 on Page 19

Magnetic Particle Clutch

The Series 900 magnetic particle clutch has a normal operating torque ranging from 0 to 8 lb-in. and a maximum recommended speed of 1500 rpm. Control windings can be furnished for 1 to 200 v operation. Clutch is suited for servo, brake, disconnect, torque limiting, and many other functions. Ask for Data 110-1. 4 pages. Lear, Grand Rapids Div., 110 Ionia Ave. N.W., Grand Rapids 2, Mich. H

Circle 610 on Page 19

Aluminum Specifications

File Folder Section G, No. 1 contains a condensed tabulation of Government specifications for aluminum products. Also charted is useful information on the bending and forming of aluminum sheet and plate. 2 pages. Peter A. Frasse & Co., 17 Grand St., New York 13, N. Y. D

Circle 611 on Page 19

Direct Current Motors

"Special Direct Current Motors and Generators for Industrial and Military Applications" is title of informative manual No. GED-3343. Data aid in solving special direct current motor applications. Various types of motors are described. 8 pages. General Electric Co., Schenectady 5, N. Y. C

Circle 612 on Page 19

Steel Mill Drives

More than 100 photos and drawings are used to show the products and experience of this company in the steel and related industries. Brochure Q-23A covers steel mill auxiliary drives, materials handling equipment, sintering plants, tube mills, and hot and cold rolling mills. Shown are complete electrical systems ranging from main motor-generators to auxiliary motors and controls. 40 pages. Elliott Co., Jeannette, Pa. G

Circle 613 on Page 19

High Vacuum Equipment

Standard and custom high vacuum components, equipment, and systems are subject of illustrated product summary and price list. Data are given on all types of mechanical and diffusion pumps, gages, valves, furnaces, altitude chambers, and vacuum coating equipment. 16 pages. NRC Equipment Corp., 160 Charlemont St., Newton 61, Mass. B

Circle 614 on Page 19

Magnetic Relay

Compact and accessible for maintenance, type PM magnetic relays described in Bulletin PL-7305 feature sectional pole construction and have 10-amp rating. They can be supplied with 2 to 12 poles in various combinations and pole arrangements. 8 pages. Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio. F

Circle 615 on Page 19

High Purity Metals

Helpful facts to aid in ordering and purchasing ultra high purity DOT material for semiconductors and custom-formed high purity semiconductor soft solder preforms for automatic soldering are contained in illustrated bulletin. 4 pages. Alpha Metals, Inc., 56 Water St., Jersey City, N. J. D

Circle 616 on Page 19

Gears

Complete design data and technical guidance to gearing is provided by comprehensive Catalog 57. Tables, charts, dimensional drawings, formulas, and other practical information are presented on practically all types of gears and speed reducers. Gear material combinations which offer optimum strength and durability are covered. 112 pages. Horsburgh & Scott Co., 5114 Hamilton Ave., Cleveland 14, Ohio. F

Circle 617 on Page 19

Pulley Lagging

Advantages offered by Condenserite improve pulley lagging for power transmission and conveying equipment are cited in Bulletin 100. The four-ply lagging is bonded on pulleys or rollers to eliminate slippage, permit ample belt slack, lengthen belt life, and minimize strain on bearings

(Advertisement)

Applying Reliance V★S Drives in Designing Web-fed Equipment

by:
C. E. Robinson, E.E.
Section Manager
Application Engineering Dept.
Reliance Electric & Engineering Co.

A primary consideration on web-fed equipment is to maintain web continuity. If too much tension is exerted, the web will stretch or break, causing product imperfection or requiring machine rethreading. Too little tension will cause wrinkling or slack pile-up.

Reliance V★S Drives are ideal for driving and controlling web-fed processing equipment. Acceleration and deceleration rates can be programmed to prevent over and under tensioning during speed change, a critical condition for web-fed operations. Motor operating speeds can be automatically regulated to maintain correct tension under any conditions, even dead stall.

STARTING AND STOPPING PROTECTION

Figure 1 shows a typical operating cycle of a specialty printing press. This press prints and die cuts milk cartons. Paper stock is fed from a roll, and printing is done on a continuous web of paper.

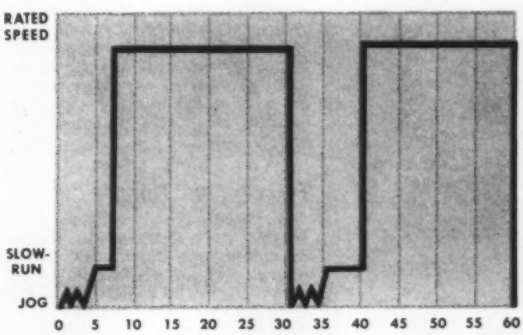


FIG. 1

A 30 hp. V★S Drive powers the press, providing speeds from jog and slow-run up to full operating speed. Speed changing is stepless and the rate of change is carefully regulated by a Reliance VSC exciter. The VSC applies voltage gradually to the motor, providing preset, automatic, linear acceleration. This press starts and stops about three times an hour. Any tearing or looping of the paper would seriously decrease production. The V★S Drive eliminates this danger.

TENSION CONTROL DURING OPERATION

Figure 2 shows a comparison between line speed and motor speed on the beamer of a textile slasher. In order to prepare the thread for weaving on the loom, it is put through a slashing operation. This consists of immersing thousands of individual strands in hot sizing, and winding them onto a wide roll or beam. Between the bath and the beamer are delivery rolls to tension the threads as they are wound.

A 5 hp. V★S drives the beamer, keeping unvarying tension on the delicate threads. Drive motor speed decreases during winding, maintaining constant tension as the roll builds. A Reliance VSR Regulator, through a feed-back loop, measures and controls the current drawn by the motor. As the beam builds up, the motor tries to draw more current. By keeping the current constant, the motor slows down in direct relationship to the build up of the beam. The V★S Drive will hold a constant tension from start to stop. If a mechanical jam should stop the slasher, the VSR will maintain tension even with the motor stalled.

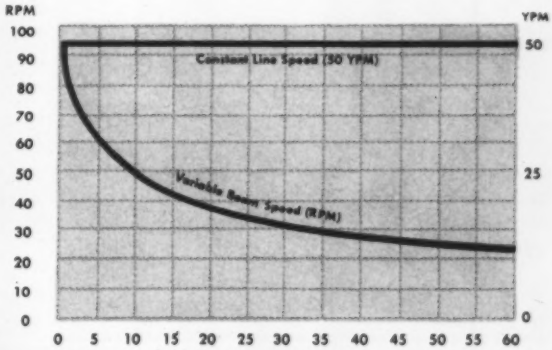


FIG. 2

V★S DRIVE COMPONENTS

A V★S Drive operates from standard a-c. power lines and consists of three basic components: d-c. drive motor, packaged motor controls and operator's control station.

Reliance drive motors change speed over a wide range, smoothly and without speed steps. The all electric design permits the inclusion of built-in dynamic or regenerative braking, giving fast, maintenance-free stopping power.

Motor-generator sets or electronic rectifiers, working from plant a-c. power lines, form the nucleus of the motor control unit. A series of built-in controls regulate voltage and current in the system. With these controls, any required combination of speed, horsepower, torque and time characteristics are produced.

If you would like further information on how you can use V★S Drives when designing your product, contact your local Reliance representative, or write for Bulletin No. D-2506. D-1585

RELIANCE ELECTRIC AND ENGINEERING CO.
Dept. 283A, Cleveland 17, Ohio
Canadian Division: Toronto, Ontario
Sales Offices and Distributors in principal cities

Circle 492 on Page 19

SPACE IS Valuable

... So Use the A. W. HAYDON company's

SUB-MINIATURE HERMETIC ELAPSED TIME INDICATORS.

You, too, can afford the space to keep track of time! From now on, these really small (1¼") Elapsed Time Indicators will keep company with the best of Electronic Miracles.

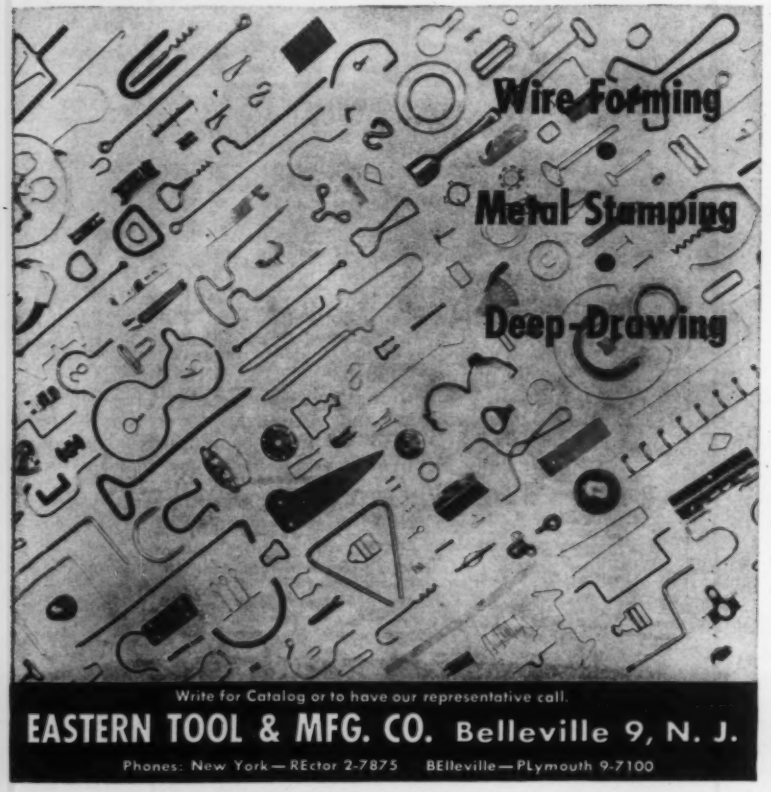
The illustration shows how the operating time of various sections of an electronic console can be monitored.

The dial type units read up to 2,500 hours in one hour increments, while the digital type units read up to 9999.9 hours in one-tenth hour increments. Designed for military applications, these 4½ ounce units can save valuable panel space in industrial and electronic applications.

The 400 cycle models now in production are described in Bulletin AWH ET 602.

The A.W. HAYDON COMPANY
249 NORTH ELM STREET
WATERBURY 20, CONNECTICUT
Design and Manufacture of Electro-Mechanical Timing Devices

Circle 493 on Page 19



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Phones: New York—REctor 2-7875 BElleville—PLymouth 9-7100

Circle 494 on Page 19

HELPFUL LITERATURE

and machine parts. 4 pages. Condenserite Engineering Corp., 2015 Chancellor St., Philadelphia 3, Pa. E

Circle 618 on Page 19

Electric Control Centers

Typical control centers, their applications and major components are subject of bulletin entitled "JIC Control Centers." Units integrate and centralize the controls of electric motor equipment. J. I. C. Electric Co., 19255 W. Davison St., Detroit 23, Mich. H

Circle 619 on Page 19

Electrical Contacts

Properties and uses of the Gibson line of electrical contacts are covered in detail in General Catalog C-520. Properties of a wide range of contact materials are presented, and selection guidance is offered for their use in all types of controls and equipment. 16 pages. Gibson Electric Co., Box 614, Delmont, Pa. G

Circle 620 on Page 19

Shaft-Mounted Drives

Described in Bulletin 7100 is a complete line of steel, helical gear, shaft mounted drives for applications in the range of ½ to 50 hp and from 420 to 5 rpm output speed. Design and construction of drives are discussed, and typical drive problems are solved. 32 pages. Falk Corp., 3001 W. Canal St., Milwaukee 1, Wis. K

Circle 621 on Page 19

Rotary Solenoids & Switches

Ledex rotary solenoids, selector switches, hermetically sealed selectors, and Syncramental stepping motors are described in Bulletin 1157LS. Torque charts are included for all stock solenoid models. 4 pages. G. H. Leland, Inc., 123 Webster St., Dayton 3, Ohio. G

Circle 622 on Page 19

Forged Pipe Flanges

Approximate weights of B&W forged steel flanges for up to 24-in. diameter pipe in the 150 to 2500 psi pressure range are tabulated in Technical Data Card FDC-251. 2 pages. Babcock & Wilcox Co., Tubular Products Div., Milwaukee 46, Wis. K

Circle 623 on Page 19

Fans & Cyclone Separators

Catalog section 500-C describes industrial fans and cyclone separators and their uses. Included are drawings of standard fan units, charts of dimensions and outlet velocities, capacities, rpm's and horsepowers; plus data on standard cyclone separators. Engineering data on the latter are included. Fort Worth Steel & Machinery Co., 3600 McCart St., Fort Worth 10, Tex. I

Circle 624 on Page 19

Photodrawings

"Photodrawings" is title of booklet which describes the modern technique of using photographs to convey engineering drawing information in an easy-to-visualize form. Photographs are reproduced on a translucent material on which engineering detail and superimposed sketches

can be added. From this, work prints can be made by conventional processes. 12 pages. Eastman Kodak Co., Sales Service Div., Rochester 4, N. Y. F

Circle 625 on Page 19

Design of Springs

"How to Solve Your Spring Design Problems" is theme of illustrated brochure. Typical examples of spring design problems which were solved by early consultation are cited. Examples of various types of springs and their characteristics are shown. 12 pages. Associated Spring Corp., Bristol, Conn. B

Circle 626 on Page 19

Relays

Prices, model numbers, and other data on a complete line of relays made by all leading relay manufacturers are tabulated in illustrated catalog. One-day delivery on these components is offered. 36 pages. Relay Sales, Box 186, West Chicago, Ill. I

Circle 627 on Page 19

Glassed Pumps

Authoritative answers to over 30 frequently asked questions about glassed pumps are given in Booklet 5281-J. These steel pumps will handle corrosive liquids. All parts coming in contact with the liquid are glassed. 16 pages. Goulds Pumps, Inc., 42 Black Brook Rd., Seneca Falls, N. Y. D

Circle 628 on Page 19

Chemical Feeders

Manzel chemical feeders are single or multi-feed metering pumps for precise measuring of practically all liquids. Deliveries range from as low as 1 cc/min/feed to as high as 1 gal/min/feed against pressures up to 5000 psi. These feeders which handle corrosive chemicals, acids, alkalies, compounds, and oils, are described in Brochure No. 1136. 32 pages. Houdaille Industries, Inc., Manzel Div., 315 Babcock St., Buffalo 10, N. Y. F

Circle 629 on Page 19

Electromechanical Products

Design, engineering, and manufacturing facilities of this company are pictured along with typical electromechanical and electronic products and systems made. Products include power supplies, actuators, blowers, timing devices, and inverters. 46 pages. Western Design & Mfg. Corp., Santa Barbara Airport, Goleta, Calif. L

Circle 630 on Page 19

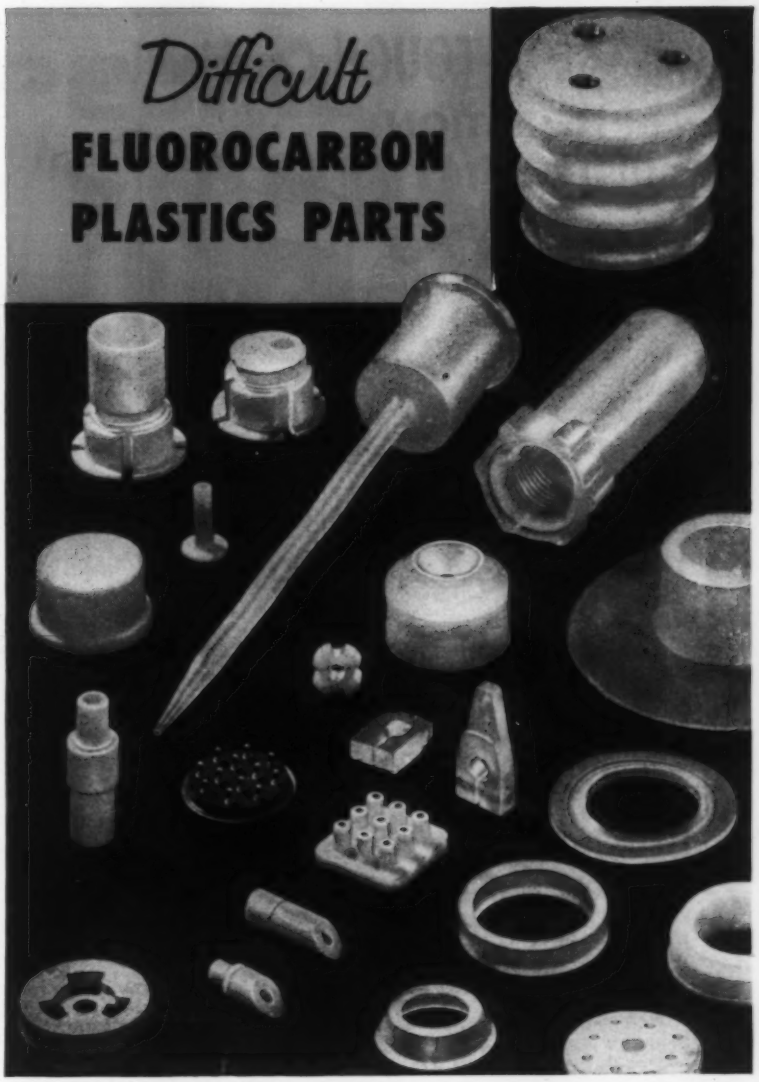
Torque Control Fastener

Advantages and technical details of the Hi-Lok fastener which offers controlled preload through built-in torque control are covered in illustrated Catalog 2-1506. Application data are given, as are available materials and sizes. 4 pages. Hi-Shear Rivet Tool Co., 2600 W. 247th St., Torrance, Calif. L

Circle 631 on Page 19

Metallic O-Rings

Engineering data relative to pressurized, self-energized, and standard



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Circle 495 on Page 19

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. . . of FILTRATION REQUIREMENTS?

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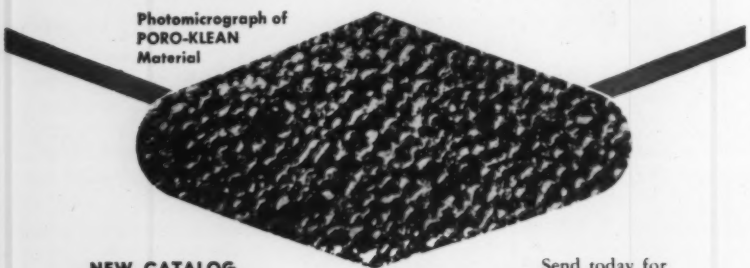
Photomicrograph of PORO-KLEAN Material



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EDGE-TYPE, WIRE-WOUND, FIBER CARTRIDGE and POROUS METAL FILTERS

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metallic O-rings are provided in Bulletin 576191. O-rings are used to form a pressure-tight joint between two flat machined surfaces and function at temperatures from −70 to 1800° F and pressures up to 10,000 psi. 16 pages. United Metallic O-Ring Corp., Box 1035, Dayton, Ohio. C

Circle 632 on Page 19

Dial Indicators

Dimensional data on 2¼-in. diameter Sema dial indicators are given in Bulletin 200. The six models pictured have total ranges from 0.025 to 0.250 in. Offered with bulletin is a conversion chart for company's portable hardness tester. 4 pages. Sema Corp., Box 176, Boston 72, Mass. B

Circle 633 on Page 19

Wire Cloth Calculator

Direct reading of the percentage of open area of any wire cloth with from 1 to 100 meshes per inch is given by this slide-rule calculator. Readings provide flow rate data required in filtration applications. Available to wire cloth fabricators and designers by writing National-Standard Co., Reynolds Wire Div., Dixon, Ill. I

Circle 634 on Page 19

Selector Valve

Available literature on a motorized four-port selector valve includes two bulletins and an engineering drawing. This small, lightweight valve is for high flow rates at high hydraulic pressure. 6 pages in all. United Hydraulics, Inc., 110 Terrell Court, Dayton 7, Ohio. G

Circle 635 on Page 19

Motor Starters

Bulletin 11-000 describes ac magnetic, full voltage Life-Linestarter used for across-the-line starting of squirrel cage induction motor, or for primary control of wound rotor motors. Sizes 0 through 4 and 5 through 8 are covered. 16 pages. Westinghouse Electric Corp., Standard Control Div., Beaver plant, Beaver, Pa. F

Circle 636 on Page 19

Alloy Steel Tubing

Prices, heat treating data, and machining recommendations relative to alloy steel mechanical tubing are presented in stock list. The 52100 oil hardening grade and electric furnace 4720 and 4320 carburizing grades are detailed. 12 pages. Timken Roller Bearing Co., Steel & Tube Div., Canton 6, Ohio. F

Circle 637 on Page 19

Variable Speed Drives

Complete Sterling line of variable speed drives is covered in descriptive Bulletin 195 which illustrates several Speed-Trol motor applications and provides selection information. 8 pages. Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles 22, Calif. L

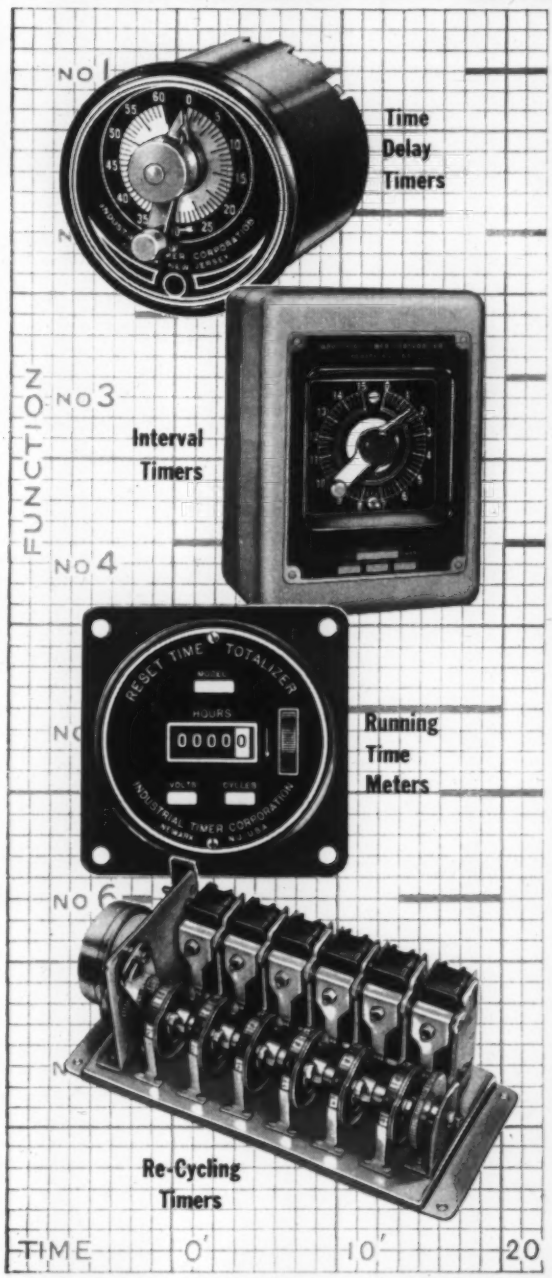
Circle 638 on Page 19

Rust Preventive Spray

Various properties of Rust Veto Spray for all metal surfaces are outlined in data sheet 2-203. Offered in spray containers, the rust preventive

Circle 496 on Page 19

Need a "SPECIAL" TIMER ...need a "STANDARD"?



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Circle 497 on Page 19

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Circle 639 on Page 19

Welded Steel Tubing

Sizes, gages, and finishes available in welded steel tubing are listed in catalog. Views representing milling operations are shown. 4 pages. Southern Fabricating Co., Sheffield, Ala. A

Circle 640 on Page 19

Gearshift Drives & Motors

Available literature includes Bulletins RS-2, FD-EX-1, and TE-E-RE-1 which respectively describe dripproof, dust-tight and explosion-proof, and totally enclosed fan-cooled and nonventilated industrial motors. Bulletin DB-4 covers gearshift drives for machine tools and processing equipment. Lima Electric Motor Co., Lima, Ohio. G

Circle 641 on Page 19

Barrel Finishing Process

A clear explanation of the mechanical finishing process using barrel equipment is set forth in catalog. Roto-finishing as applied to grinding, deburring, descaling, polishing, and coloring of metal parts is discussed. 24 pages. Roto-Finish Co., Kalamazoo, Mich. H

Circle 642 on Page 19

Potentiometers & Motors

Ten and three-turn Micropot potentiometers, ten-turn Microdials, and synchronous and induction motors are described with full engineering data in Catalog BED-A56. Special resistance values up to 300,000 ohms are available. 24 pages. George W. Borg Corp., Borg Equipment Div., 120 S. Main St., Janesville, Wis. K

Circle 643 on Page 19

Counting Instruments

Condensed catalog and price list AD 340 covers electric counters, counter actuators, stroke counters, revolution counters, and automatic batch counters. 4 pages. Production Instruments, 8080 McCormick Blvd., Skokie, Ill. J

Circle 644 on Page 19

Die Cast Fasteners

Die cast industrial and molded nylon fasteners are described with complete dimensional information in Form F-2. Covered are wing, cap, and thumb nuts; thumb and wing screws; nylon machine screws, bushings, washers, and special fasteners; and zinc alloy tubular rivets. 8 pages. Gries Reproducer Corp., 125 Beechwood Ave., New Rochelle, N. Y. D

Circle 645 on Page 19

Pressure Gage

Brief description of a pressure gage with solid front nonmetallic case is provided in bulletin. Norden-Ketay Corp., Instrument and Systems Div., Milford, Conn. B

Circle 646 on Page 19

Electrical Housings

Selection and specification data for an extensive line of cast aluminum weatherproof and explosionproof housings and junction boxes are offered

Circle 498 on Page 19

BOSTON Gear adds NEW types and sizes to provide

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NOW — you can meet any drive need — light to heavy duty — with standardized roller, block, or ladder chain and sprockets OFF-THE-SHELF from your BOSTON GEAR DISTRIBUTOR — AT FACTORY PRICES.

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7124 "OFF-THE-SHELF" TRANSMISSION PRODUCTS **FROM STOCK** — AT FACTORY PRICES — ASK FOR CATALOG
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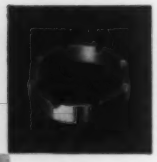

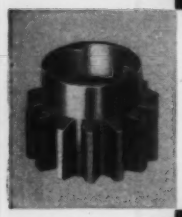

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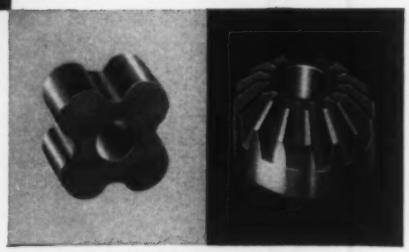

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in Bulletin 158. A full complement of explosionproof sealing fittings is also shown. 16 pages. Adalet Mfg. Co., 14300 Lorain Ave., Cleveland 11, Ohio. F

Circle 647 on Page 19

Modular Enclosure System

With the Emcor modular enclosure system an engineer can tailor-make his own enclosure, housing, or cabinet for instruments, electronic equipment, and related apparatus. Catalog 105 pictures and specifies the various components which comprise the system and how they can be combined into desired arrangements. 36 pages. Elgin Metalformers Corp., 630 Congdon Ave., Elgin, Ill. J

Circle 648 on Page 19

Pyrometer Supplies

Buyers' Guide G100-8 describes line of thermocouple accessories for measuring temperature. Base metal, small mass, noble metal, and special purpose thermocouples as well as mounting attachments, thermocouple components, charts, and inks are covered. 52 pages. Minneapolis Honeywell Regulator Co., Industrial Div., Wayne & Windrim Ave., Philadelphia 44, Pa. E

Circle 649 on Page 19

Electronic Instruments

More than 40 accelerometers, high temperature strain gages, and associated electronic equipment are described in catalog. Engineering drawings, tables, and graphs give specifications and performance data. 32 pages. Columbia Research Laboratories, MacDade Blvd. & Bullens Lane, Woodlyn, Pa. E

Circle 650 on Page 19

Servo Systems

Plug-in servo repeater systems and subminiature servo amplifiers are covered in file folder and specification sheets. Micromation is discussed. Waldorf Instrument Co., Huntington Station, Long Island, N. Y. D

Circle 651 on Page 19

Cold Rolled Strip

Price comparison charts for cold rolled flat wire and strip are found in bulletin. Forming a basic buying guide, they show basic price differential between these two products and Monel, nickel, Permanickel, Inconel, stainless steels, beryllium copper, and other metals. 4 pages. Techalloy Co., Rahns, Pa. E

Circle 652 on Page 19

Handlers, Tools, Heaters

Vibrators, packers and jolters, screens, parts feeders, shaft seals, selenium rectifiers, infrared heating elements and panels, power tools, and other equipment are listed in condensed Catalog 5712. Illustrations, descriptions, and specifications are included. Syntron Co., 260 Lexington Ave., Homer City, Pa. F

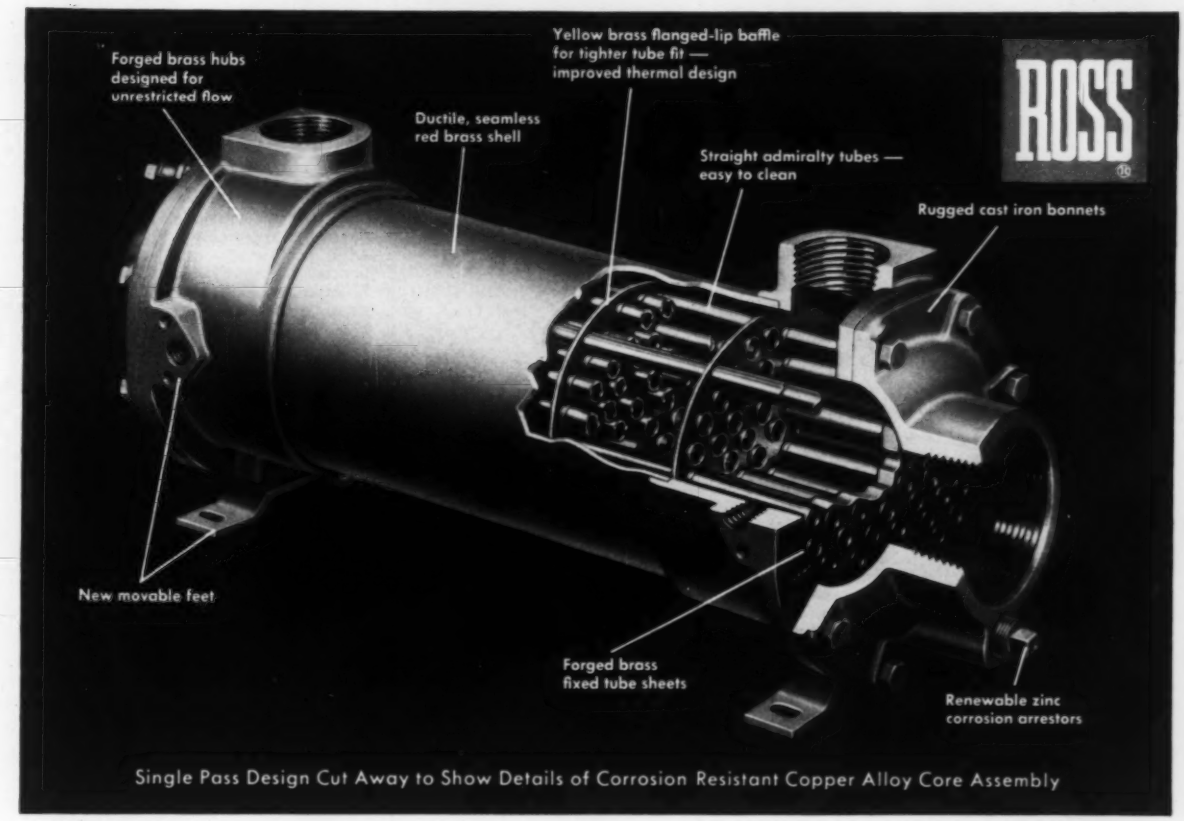
Circle 653 on Page 19

Templates

Photographs and descriptions of 91 templates are found in the seven sections of Catalog 60. Electrical, mechanical engineering, general, architectural, processing, and other tem-

LOOK AT THE LEADER'S LATEST . . .

'58 design of a famous line . . . Ross BCF Exchangers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Yellow brass flanged-lip baffle for tighter tube fit — improved thermal design
ROSS
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Straight admiralty tubes — easy to clean
Rugged cast iron bonnets
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Single Pass Design Cut Away to Show Details of Corrosion Resistant Copper Alloy Core Assembly

LOOK AT THE LIST . . . new design features, new sizes, new capacities, new mountings, new materials . . . *new low prices!* In 1958 the leader and originator of small, compact, fully standardized exchangers takes another step forward.

The Ross Heat Exchanger Division of American-Standard originated the whole BCF idea 14 years ago. Before then, pre-engineered design, mass produced parts and stocked assemblies were untried for a unit of this type. Designers and users of original equipment were quick to adopt the BCF as standard. Today, on a larger scale than ever, it is cooling lube oil, jacket water, hydraulic and other fluids for a wide variety of industries.

But, even with such success, the BCF has never been permitted to stand still. Ross has persisted in making constant design refinements and performance improvements . . . *1958 is typical: New* baffles with flanged lip at each tube hole and around outer edge for tighter fit and improved thermal characteristics. *New* stamped steel feet, movable in three positions around hubs for easy, more adaptable mounting. *New* sizes and capacities . . . 46 models . . . one, two or four pass designs . . . giving greater selection than ever before.

Look at the leader's latest. Send in the coupon below for the new Ross Bulletin . . . an up-to-date run down on the 1958 Ross Type BCF Exchanger.

Mail this coupon for new Ross Bulletin

To: **American-Standard,** MD
Ross Heat Exchanger Division
Buffalo 5, N. Y.

Please send, without obligation, your new Bulletin 1.1K6 describing the 1958 Ross Type BCF Heat Exchanger.

NAME _____

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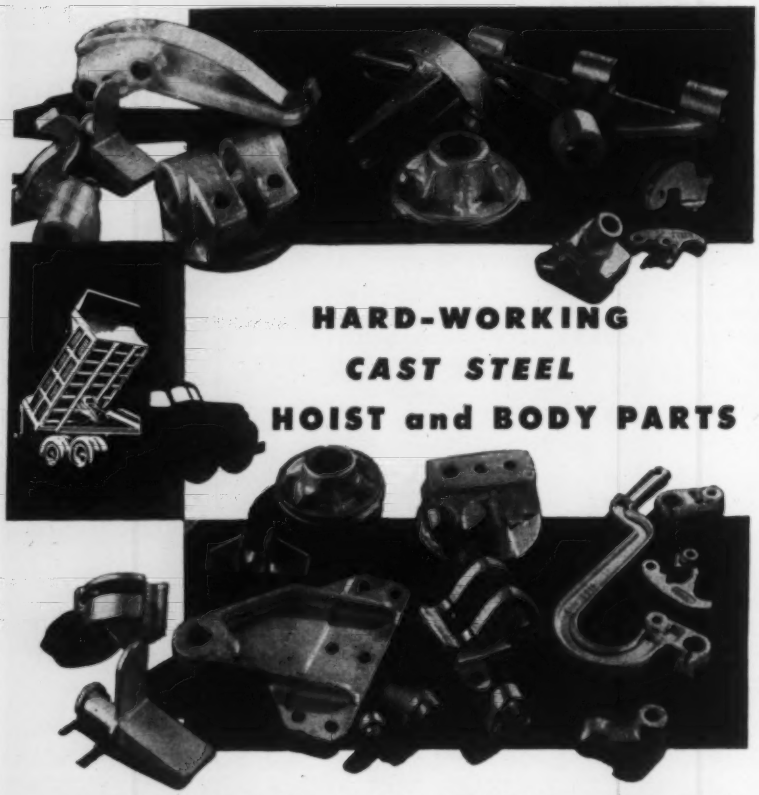
American-Standard PRODUCTS

AMERICAN-Standard

ROSS HEAT EXCHANGER DIVISION



...made *BETTER* with UNITCASTINGS!

When heavy-duty truck equipment is subjected to terrific poundings, extremely heavy loads, shocks, and stresses—its durability, ruggedness, and ability to "take it" depends on the quality of the components.

Steel castings are used for many of the "wear" parts in a major manufacturer's line of hoists and bodies because they "stand up" on the job . . . assure the required strength, resistance to wear and corrosion . . . offer good weldability and minimum weight.

"Foundry Engineered" Unitcastings meet the dimensional accuracy, internal soundness, good surface appearance and other requirements specified by the customer. In addition, Unitcast's modern steel casting methods and facilities make possible the *consistent uniformity* that means a *lower end cost!*

Let Unitcast's engineers show you how steel castings will serve you better! Write today for complete information.

UNITCAST CORPORATION, Toledo 9, Ohio

In Canada: CANADIAN-UNITCAST STEEL, LTD., Sherbrooke, Quebec

Unitcast

SPECIFICATION STEEL CASTINGS

plates are shown. 16 pages. Rapidesign, Inc., Box 429, Burbank, Calif. L

Circle 654 on Page 19

Hydraulic Hose Fittings

Reusable Hoze-lok fittings for use with rubber-covered, wire-braided hydraulic hose in 3/16 to 1 1/8-in. OD sizes are described in illustrated Catalog 4440. Fittings are no-skive type. Assembly instructions are included. 8 pages. Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio. F

Circle 655 on Page 19

Automatic Valves

Brief descriptions of Cash-Acme pressure reducing and regulating, back pressure, and diaphragm-operated control valves are content of illustrated Bulletin 7F. Easy-to-use resume of seven different valves and their specifications are given. 4 pages. A. W. Cash Valve Mfg. Corp., Box 191, Decatur, Ill. I

Circle 656 on Page 19

Waveguide Windows

Waveguide pressure windows and their uses are described in illustrated folder. They freely propagate RF energy over a restricted bandwidth and offer an equipment seal against humidity and dust. Data on available units are given. 4 pages. Microwave Associates, Inc., Burlington, Mass. B

Circle 657 on Page 19

Autocollimator

"Testing Circular Division with Precision Polygons" is title of paper which describes and illustrates use of precision reflecting polygon with a Microptic autocollimator to check circular spacing accuracy of rotary tables and other devices. Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill. J

Circle 658 on Page 19

Self-Aligning Coupling

Low-priced all steel, gear type, self-aligning Fast Model B coupling, produced in shaft sizes up to 3⅛ in., is subject of illustrated brochure. Its double engagement design compensates for any type of shaft misalignment. Koppers Co. Metal Products Div., Baltimore 3, Md. C

Circle 659 on Page 19

Vulcanizing Agents

Two studies on dimethylol phonol resins as vulcanizing agents for Butyl rubber assist the compounder in evaluating this curing system. Bulletin 100-4 describes system using Amberol St-137 phenol formaldehyde resin and Bulletin 100-4B covers other resins. Thiokol Chemical Corp., 780 N. Clinton Ave., Trenton 7, N. J. E

Circle 660 on Page 19

High Strength Steels

Complete design and application data are given on N-A-X High Tensile and N-A-X Finegrain high strength steels in technical bulletin. Tables list composition, physical properties, engineering data, heat treatment, and fabricating properties of these materials. 12 pages. Write on company letterhead to Great Lakes Steel Corp., N-A-X Alloy Div., Detroit 29, Mich. H

SYNCHRON®
TIMING MOTORS

Precision Engineered for Dependable Power

UL and CSA approvals

SYNCHRON synchronous motors operate smoothly, evenly in any position at temperatures from −40° to +140° F., start instantly under load; pull up to 20 in. oz. at 1 RPM. Available in 42 speeds from 0.8 RPM to 600 RPM.

1 **PATENTED TWO-PIECE FIELD STRUCTURE** having wide and narrow poles, with rotor that rotates between inner and outer field poles. The inner and outer poles are properly shaded with heavy, continuous copper rings to assure maximum starting and running torque.

2 **DOUBLE BEARINGS** in reduction train on rotor shaft assure smooth operation.

3 **ALUMINUM ROTOR RING SUPPORT.**

4 **PATENTED, HARDENED STEEL ROTOR RING.**

5 **OIL STORAGE RESERVOIR** with patented oil feed to bearings.

6 **HEAVY BRASS ROTOR COVER.**

7 **DOUBLE BEARINGS ON OUTPUT SHAFT.**

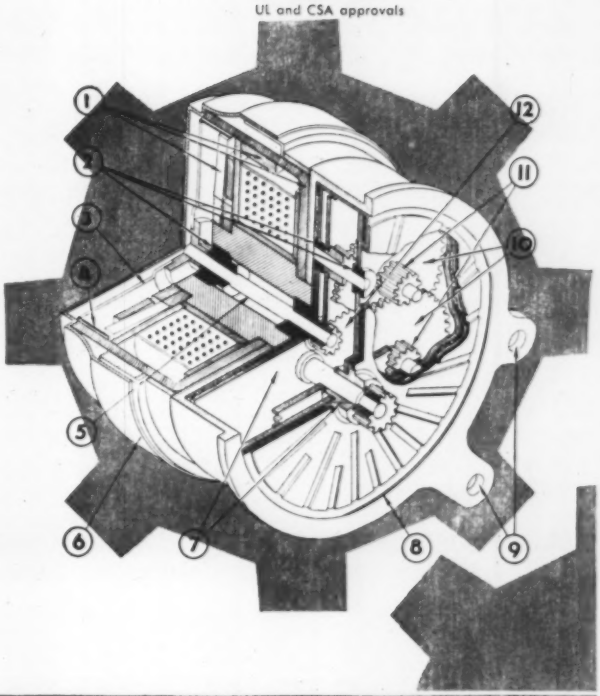
8 **GEAR CASE SEALED** against oil leakage to permit mounting in any position.

9 **FOUR CONVENIENT MOUNTING HOLES.**

10 **BRASS GEARS.**

11 **STEEL PINIONS.** Note: Brass against steel assures longer life.

12 **BAKELITE GEAR** for quiet operation.



STANDARD TIMING MOTOR (8 IN. OZ.)
Compactly built to space saving dimensions, with rotor and coil packed in a sturdy hand - sized case. Used in timing devices and controls of all types. Guaranteed torque 8 in. oz. at 1 r.p.m.

HI-TORQUE TIMING MOTOR (20 IN. OZ.)
There's big power packed into this versatile timing motor. One year guarantee. Dependable, accurate, trouble-free. Guaranteed torque 20 in. oz. at 1 r.p.m.

SLO-MOTION SYNCHRON (1 R.P.H.)
A new timing motor developed especially for slow motion jobs. Guaranteed 20 in. oz. at 1 r.p.h. (1/60 r.p.m.)

HANSEN CLOCK MOVEMENTS
For standard and office clocks, sign clocks, novelty clocks, and clocks of all kinds up to 26" in diameter under glass. Precision power with a Synchron timing motor.

HANSEN MAGNA-TORC DC MOTOR
Designed for aircraft instruments and radio controls. Armed Forces applications have proved its top performance worldwide under all operating conditions. Easily adapted to commercial uses.

WRITE FOR NEW ILLUSTRATED BROCHURE OF FULL SYNCHRON LINE OR SEE IT IN SWEET'S CATALOG

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OUR 50TH YEAR

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FOR FULL INFORMATION CALL OR WRITE TODAY

HANSEN REPRESENTATIVES: The Fromm Co., 5150 W. Madison St., Chicago, Ill.; Winslow Electric Co., 123 E. 37th St., New York, N.Y.; Electric Motor Engineering, Inc., Los Angeles WEBSTER 3-7591 and Oakland, Calif.; H. C. Johnson Agencies, Inc., Rochester, Buffalo, Syracuse, Binghamton and Schenectady, New York

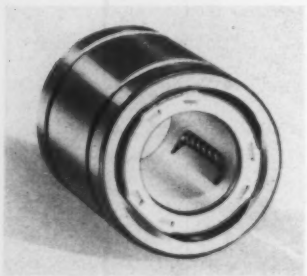
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Ball Bushing

for instruments, controls, and other components

New ball bushing, designated INST-4812, has application in many types of instruments, controls, and other components where extremely low-friction linear motion is desired. Recirculating ball principle used in the bearing provides unlimited travel which enables instruments to have a wide range. Threshold sensitivity is 20 min or less with 3-oz weight on bearing. Instrument bearing is extremely rugged, withstands high vibration and g-forces present in missiles and aircraft. Construction provides through passages between ball retainer and outer sleeve. Bushing has nominal OD of 0.5000 in. and length of 0.750 in. Bearing weighs 0.02 lb and has rolling load rating of 13 lb and static load rating of 22 lb. **Thomson Industries Inc.**, Manhasset, L. I., N. Y. D



Circle 661 on Page 19

Adjustable Cam Assembly

for use in servomechanisms

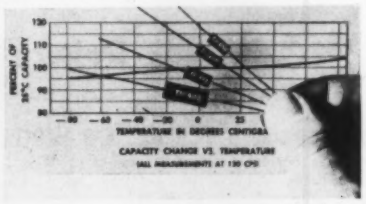
New adjustable cam assembly, Model T-159, is for use in servomechanisms where switches and similar devices are actuated at predetermined angular limits. Two stainless-steel cams can be rotated relative to each other to permit adjustment between rise from zero to 180 deg. Balanced clamp secures assembly to shaft as well as locking cams for desired setting. Maximum diameter is 1⅛ in., and hubs are available for 1/8, 3/16, and 1/4-in. shafts. **Sterling Precision Corp.**, 54-17 Lawrence St., Flushing 54, N. Y. D

Circle 662 on Page 19

Electrolytic Capacitors

of solid tantalum

Tan-Ti-Cap capacitors are designed primarily for use in miniaturized circuitry where both reliability and temperature stability are vital factors. They are available in 18 ratings. Five capacitors are 6-v units ranging from 22 to 200 mf, five are 15-v devices from 10 to 100 mf, five are 25-v capacitors from 5 to 55 mf, and four are 35-v units from 4 to 25 mf. Units are constructed of a solid pellet of pressed, sintered tantalum powder with an integral wire lead. Dielectric is formed by a tantalum-derived coating deposited electrochemically on the pellet, resulting in a semiconductor-type junction with solid electrolytic. Pellet is solidly embedded within a case to withstand high and low-frequency vibrations and high impact. Case size ranges from 0.358 x 0.173 to 0.700 x 0.264 in. Units can be mounted vertically or horizontally on printed-circuit boards within a minimum of space. Leads can be bent sharply in any direction. **Texas Instruments Inc.**, P. O. Box 312, Dallas, Tex. I

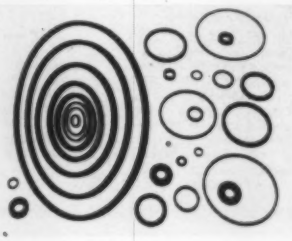


Circle 663 on Page 19

Rubber Seals

rectangular-section rings are interchangeable with O-rings

Tetraseal rectangular-section rings meet close tolerances set up for standard O-rings. They are interchangeable with O-rings, using the same groove, require no special tooling, and on static applications provide a high-performance, economical seal. Rings can be fabricated from standard or special compounds of natural, synthetic, and silicone rubbers to meet requirements for resistance to temperature extremes, acid and oil resistance, low compression set, and other properties. **Goshen Rubber Co. Inc.**, Goshen, Ind. J



Circle 664 on Page 19

Set Screws

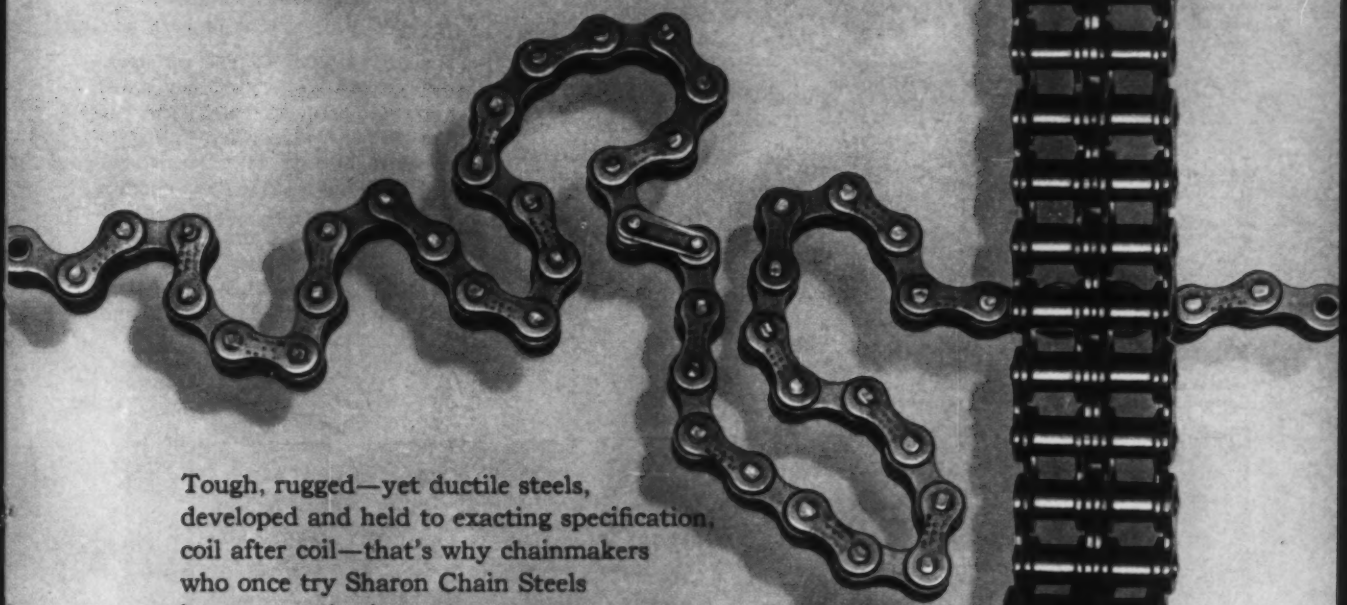
are stainless steel with nylon insert

Type CS No-Mar set screws eliminate the need for split-hub gears and clamps. They permit positive

Circle 504 on Page 19→

Better Chains...

BEGIN WITH SHARON QUALITY CHAIN STEELS



Tough, rugged—yet ductile steels, developed and held to exacting specification, coil after coil—that's why chainmakers who once try Sharon Chain Steels become regular buyers.

If you are in the business of making chain, why not talk to Sharon metallurgists and take advantage of the first-hand knowledge of chain steels that comes from years of developing special alloys for the chain industry.

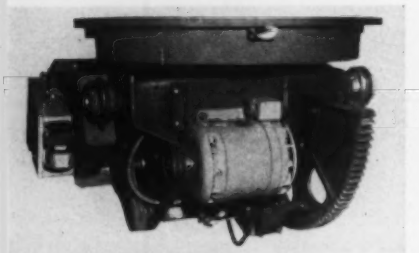
SHARONSTEEL

SHARON STEEL CORP.

SHARON, PENNSYLVANIA

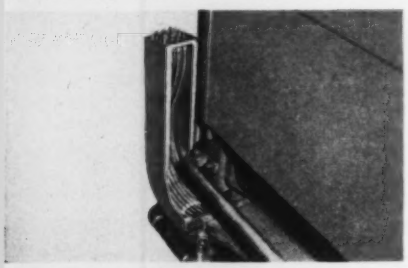
FLEXIBLE SHAFTS

...solve 3 design problems!
...save money on all 3!



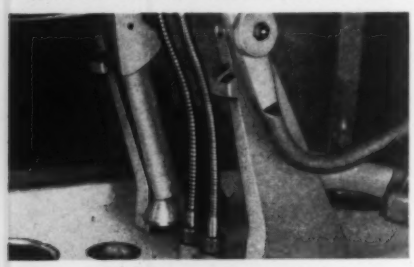
ROTARY WELDING POSITIONER

By using Robertshaw Flexible Shafting, the speed of the rotating welding table can be adjusted remotely allowing for the adjustment knob to be in a position most advantageous to the operator.



PRINTING PRESS

Robertshaw Flexible Shafting is used for ink fountain control on this modern printing press. 16 flexible connections to the keys controlling the fountain, provide a simple, economical way of achieving remote control.



POPCORN MACHINE

This popcorn machine tilts to various positions, demanding flexibility in the connections. Robertshaw Flexible Shafts transmit movement from the driving motor to the agitator... efficiently and at low cost.

Design and assembly simplification . . . no misalignment problems . . . unit weight and space savings . . . elimination of gears and exposed moving parts . . . these and many more advantages can be yours when you design with Robertshaw Flexible Shafting.

We are familiar with hundreds of applications for flexible shafts in such diverse fields as aircraft, automotive, appliance, machinery, radio, TV, electronic, portable tool and many more, including special applications which are "right down our alley". We'll work with you on any possible use.

Write for new catalog No. 233

. . . the most up-to-date data on flexible shafting in the industry!

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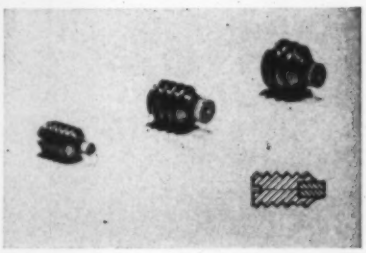
FLEXIBLE SHAFT DIVISION • 110 Summit Ave., Chatham, N. J.



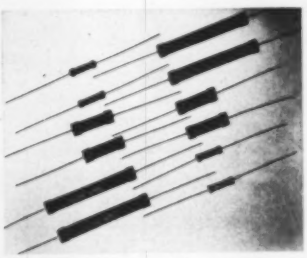
locking, because nylon insert takes the shape of the holding member. Parts can be removed without burrs or marks. Of stainless steel with nylon insert, screws are available in sizes No. 2-56, 4-40, and 6-32. **PIC Design Corp.**, 477 Atlantic Ave., East Rockaway, N. Y. D

Circle 665 on Page 19

Film-Type Resistors

have temperature coefficient of ±0.015 per cent per deg C

N and S-style film-type resistors, available in ½, 1, and 2-w sizes, have temperature coefficient of ±0.015 per cent per deg C. S-style resistors operate at temperatures to 200 C and N-style units operate to 140 C. Specifications of all N and S-style resistors meet requirements of MIL-R-10509B and MIL-R-11804B respectively. Particularly suitable for jet aircraft and



missiles - systems circuitry, units combine high-temperature rating, stability, and wide variety of resistance ranges with high degree of miniaturization. **Corning Glass Works**, Corning, N. Y. D

Circle 666 on Page 19

Bleeder Valve

operates in temperatures from −65 to 250 F

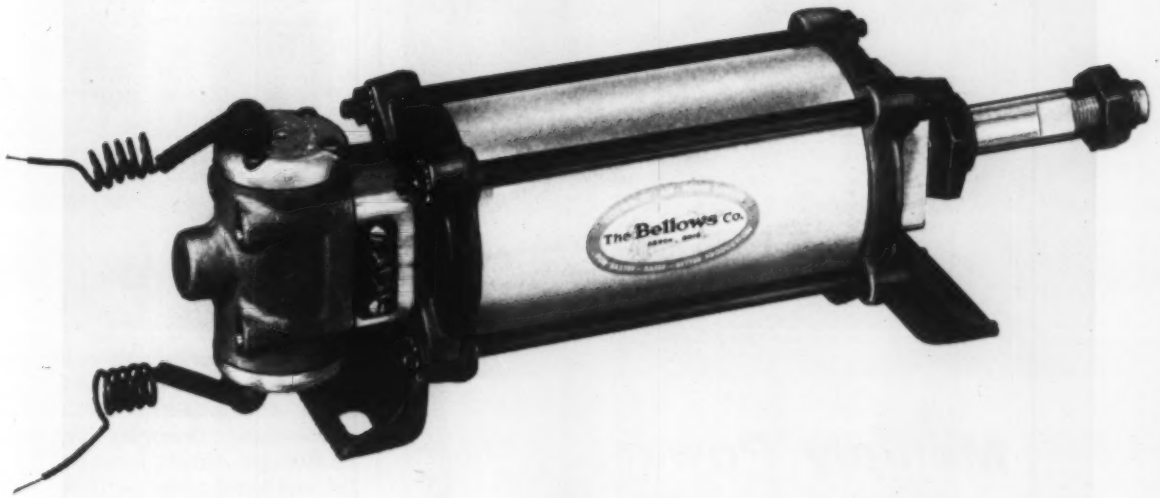
New hydraulic bleeder valve is designed for use in bleeding or purging lines in aircraft and hydraulic circuits. Discharge port can be

It is EASIER TO INSTALL

It takes LESS SPACE

Its ACTION IS FASTER

It is EASIER TO CONTROL



FOUR GOOD REASONS WHY YOU SHOULD BUY THE BELLOWS AIR MOTOR ...THE AIR CYLINDER WITH THE BUILT-IN ELECTRIC VALVE

When it comes to downright value, it's hard to visualize an air cylinder that can even approach the Bellows Air Motor. For here is a complete packaged air cylinder power unit with all controls built-in: 8-12 volt, electrically-actuated directional valve*, two independent speed controls, and an air transfer system that makes it possible to bring air to the unit through a single flexible hose. No extra valves to buy, no cumbersome piping to install.

1016-B

For detailed data — do this:

Write Dept. MD-358, The Bellows Co., Akron 9, Ohio (in Canada, Bellows Pneumatic Devices of Canada, Ltd., Toronto, 18) for Bulletin BM-25. Or, if you prefer, phone your Bellows Field Engineer—he's listed in the phone book under "The Bellows Co."

The feature of the integral valve brings important advantages. Installation is easier, electrical hook-up is simpler. It fits well in cramped quarters, or on moving machine elements. And of even more importance—the built-in valve means faster action, quicker response, less air consumption, and positive control over piston rod movement.

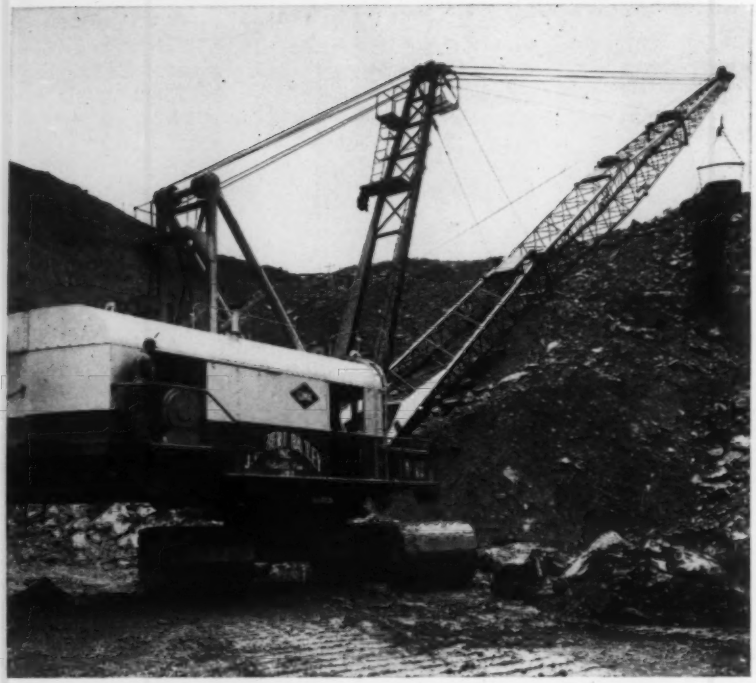
The Bellows Air Motor is made in five bore sizes: 1¼", 1¾", 2½", 3⅝" and 4½" and in any stroke length. You can have your choice of six different built-in valving arrangements, plus optional hydraulic piston movement stroke control.

*115 Volt for J.I.C. applications, if desired.

The Bellows Co.

DIVISION INTERNATIONAL BASIC ECONOMY CORPORATION

AKRON 9, OHIO



Multiply Power... Cushioning Shock

This National Torque Converter improves performance of this Lima Dragline!

Owned and operated by J. Robert Bazley Inc., of Pottsville, Pa., this dragline is stripping overburden at St. Clair, Pa.

The rocky character of the overburden, apparent in the picture, causes a lot of stress and strain during operation, and puts rapidly varying loads on the engine.

The National Torque Converter automatically "tailors" the power delivered to each load condition. When the bucket stalls, speed decreases, and torque is multiplied. As soon as resistance drops, torque decreases, and speed increases. In all phases of operations, stresses are absorbed within the Converter, easing the shocks on both equipment and operator.

National Torque Converters are manufactured with or without integral cooling systems.

If you build or operate any heavy equipment, powered between 100 and 1000 hp, National Torque Converters will help to improve performance and increase life. Write:

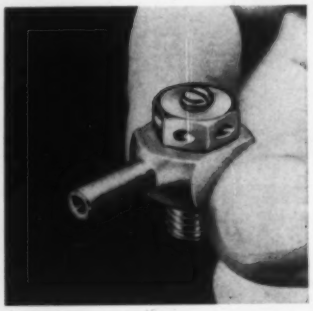
THE NATIONAL SUPPLY COMPANY

INDUSTRIAL PRODUCTS DIVISION

Two Gateway Center, Pittsburgh 22, Pa.

Pace-setters in the progress of industrial power transmission

positioned in a 360-deg plane to simplify bleeding operations in closely confined working areas. Unit operates in temperatures from −65 to 250 F. Flammable, toxic, and corrosive materials can be bled safely with the valve. Bleeding or purging can be performed while pump and system are in operation. Clear plastic tube can be used to check completion



of purging visually. Valve is cadmium-plated steel with 3/16-in. OD nozzle and 5/16-24 UNF thread connections. Operating pressure is 3500 psi, proof pressure, 7000 psi, and burst pressure, 14,000 psi. **Fluid Regulators Corp.**, 313 Gillette St., Painesville, Ohio. F

Circle 667 on Page 19

Porous Ceramic Body

retains moisture for gradual release

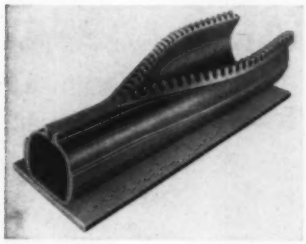
Vaporlain is manufactured from a highly porous clay, strong enough to retain its molded shape. It has applications where moisture retention for gradual release is necessary, such as in deodorizers, air conditioning equipment, and humidifiers. Material is available either unglazed or glazed in a variety of colors. Thermal expansion coefficient is 6.9 x 10^6, at 25 to 700 C, and water absorption is 40 per cent. **Star Porcelain Co.**, 34 Muirhead Ave., Trenton 9, N. J. E

Circle 668 on Page 19

Closed-Belt Conveyor

conveys bulk material sealed within belt

Zipper conveyor transports bulk materials in any plane, to considerable heights, and around obstructions. Materials are conveyed with-



in the belt, completely sealed and dust-tight. Tube is formed of one piece of flat rubber with teeth along edges. Teeth interlock as belt closes to form the rounding rectangular conduit. Belt is automatically closed by system of rollers, enclosing load within rubber sidewalls. Load is moved to point of discharge where belt automatically unloads. Belt can be discharged over the head pulley of a horizontal or inclined conveyor run, at the top of an elevator run, or on a horizontal run when belt is in an inverted position, by means of a fixed or movable belt discharger. **Stephens-Adamson Mfg. Co.**, Ridgeway Avenue, Aurora, Ill.

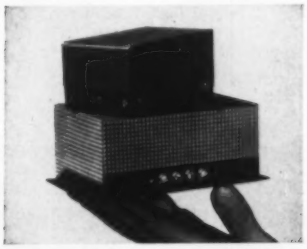
I

Circle 669 on Page 19

Electronic Control System

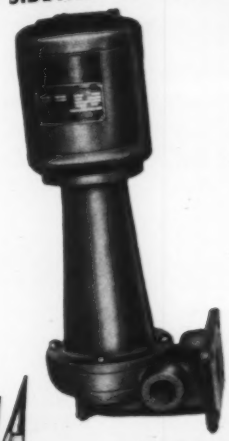
subminiature system is completely transistorized

Ra-Trol transistorized subminiature electronic control system is for garage doors, gates, freight-car grain unloaders, blast-furnace doors, photographic lighting, and other applications requiring remote control of electrical and electromechanical devices. System incorporates transistors, printed circuits, hermetically sealed components, quartz-crystal frequency stabilization, and extremely low operating voltages. Design of receiver and transmitter assures elimination of radio interference with other services. Receiver is activated only by signals generat-



NEW DESIGN FLEXIBILITY with VERSATILE IR PUMPS

FOR SIDEWALL MOUNTING



FOR IMMERSION

long-shaft, packingless pumps improve handling of coolant, cutting oils and washing liquids.

High production machines like grinders, lathes, drills, etc., industrial washers or spray bath machines depend on their integral components for sustained, trouble-free operation. This is why these Ingersoll-Rand Motorpumps are being recommended by design men everywhere.

- Packingless – long life, less maintenance, no leaks.
- Long Shaft – higher liquid level, lower draw down.
- Motor Protection – vent hole near head prevents flooding.

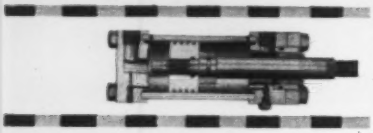
Other compact Motorpumps are available in sizes ¼ hp to 75 hp. Get the interesting performance data on Ingersoll-Rand Centrifugal pumps now.

Ingersoll-Rand

9-488 11 Broadway, New York 4, N. Y.

Circle 508 on Page 19

O-M...a Power-Full Idea in High Pressure Hydraulic Cylinders



O-M Series TH
Heavy Duty Hydraulic Cylinders
2000 PSI Shock Loads
3000 PSI Non-shock Loads • Meet JIC Standards

Tested, tried and proved powerful components in today's fast-moving automation picture, these ruggedly constructed O-M Heavy-duty Hydraulic Cylinders breeze through heavy work loads, withstand shocks and strains, and provide smooth dependable power for a wide range of pressures and operating conditions.

Important design and construction features:

1. Head Seal—"O" Ring with leather back-up washer assures positive seal between head and tube.

2. Heads confine tubing O.D. to prevent breathing and thereby provide additional insurance against leakage under the most severe conditions.

3. Heads are counterbored to pilot in accurately honed tubing to assure perfect alignment.

4. Multiple lip, self-compensating, Vee type rod gland packing.

5. Step-cut ring type pistons are standard, but Vee type pistons are available for holding application.

6. Rod-gland cartridge is removable for easy maintenance.

O-M Series TH High Pressure Hydraulic (oil) Cylinders are available in full range of sizes (1½" to 8" bores) with standard and heavy duty piston rods.

Mail coupon TODAY for Bulletin 105 showing descriptive drawings of cylinders, mounting accessories and capacity chart.

ORTMAN-MILLER MACHINE CO
7143rd Street, Hammond, Indiana
☐ Have representative call
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Company_____
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City_____ Zone____ State____

Circle 509 on Page 19

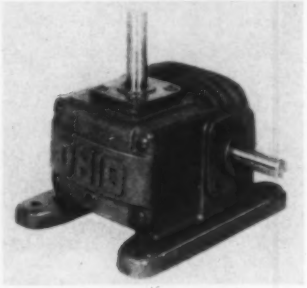
ed by transmitter. Forty different operating channels are available. Normal control range is 100 ft; however, transmitter can be adjusted to cover distances to ¼ mi. **D. W. Thomas Engineering Inc.,** 806 Robertson Blvd., Los Angeles 36, Calif. L

Circle 670 on Page 19

Speed Reducers

for use with motors to 1.5 hp

Series 20 line includes three new fin-cooled speed reducers which are single-worm-gear reduction, right-angle drive units. Completely redesigned, with heavier housings, heavy-duty antifriction bearings, and precision worms and gears, reducers include both horizontal and vertical-output shaft types. Models



are designed for use with motors to 1.5 hp. Six standard ratios are provided for each of the three basic models, ranging from 9:1 to 58:1. **Ohio Gear Co.,** 1400 E. 179th St., Cleveland 10, Ohio. F

Circle 671 on Page 19

Panel-Mounted Switches

for aircraft and computer use

Two panel-mounted switches combine advantages of both toggle and pushbutton manual control. Designed for computer and aircraft-panel use, switches feature rocker-actuators which prevent accidental operation. Series TP 1 is flush mounted and has removable translucent-plastic keys. From an external light source located inside panel, lowered half of key emits a glow, enabling easy identification of actuator position. Series TP 4 (shown) is mounted above flush and has removable transparent-plastic keys. An insert with spe-

RUGGED SALES APPEAL

In Monarch Aluminum Permanent Mold Castings

Monarch's "One Source" analysis of their end-product casting requirements enabled O. M. Scott & Sons Company to compare all casting methods before freezing final design. Monarch engineers helped determine that aluminum permanent mold castings would produce the best end-product performance.

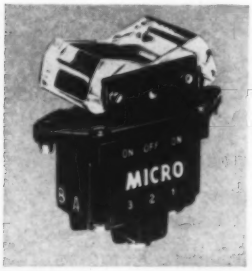
Monarch's extensive services in casting, machining and finishing provided completed castings ready for Scott's assembly.

This is a typical example of Monarch's approach to more casting value per dollar. It is underwritten by vast experience in mass-production of aluminum permanent mold, aluminum die casting, zinc die casting—machining and specialized finishing. For details how it works write for our new brochure—Today.

MANUFACTURING in MOLTEN ACHIEVEMENTS ALUMINUM

MONARCH ALUMINUM MFG. COMPANY
9205 Detroit Avenue Cleveland 2, Ohio

Circle 510 on Page 19



cific information in signs, symbols, letters, or colors can be placed under the key. High-impact plastic case resists carbon tracking from an electrical arc. Under 30 v dc resistive load, single-pole TP 1 is rated at 40 amp, two-pole TP 2 at 30 amp, and four-pole TP 4 at 20 amp. **Micro Switch, Div., Minneapolis-Honeywell Regulator Co.,** Freeport, Ill. K

Circle 672 on Page 19

Flow Limiters

for pressures to 5000 psi

New flow and rate limiters can be used with many fluids at temperatures from − 65 to 400 F. Units provide controlled flows at any pressure range to 5000 psi, with accuracy of approximately ± 1 per cent. Plunger and spring are the

only moving parts. Sizes from 0.5 to 11 gpm are available. **Conair Inc.,** 731 W. Wilson Ave., Glendale 3, Calif. L

Circle 673 on Page 19

Variable-Speed Belt

of oil and heat-resistant neoprene

New variable-speed belt does not require dismantling of machinery for installation, is precision balanced to eliminate vibration, and can be adjusted for any desired length. Made of oil and heat-resistant neoprene, belt is designed in a series of links held securely by

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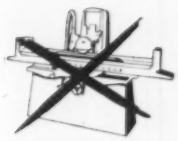
NO grinding!



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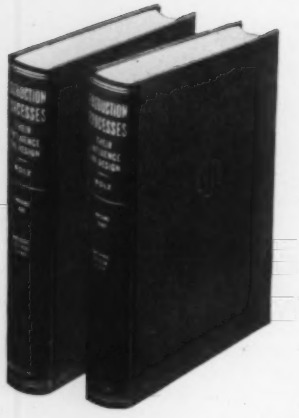
LAMINATED SHIM COMPANY, INC.

Shim Headquarters since 1913

1203 Union Street, Glenbrook, Conn.

Circle 511 on Page 19

how to design for LOW COST production



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fasteners. Adjustable to any length for use on various size drives, belt is available in a complete range of sizes. **Manheim Mfg. & Belting Co.**, Manheim, Pa. C

Circle 674 on Page 19

Servomotor Tachometer

meets BuOrd Mark-16 specifications

Type 18-MTG-6302 servomotor tachometer has operating-temperature range of −54 to 125 C, and starting voltage as low as 1½ v. Designed to meet BuOrd Mark-16 specifications, unit consists of 115-v 500-cycle two-phase size-18 servomotor with size-15 tachometer integrally mounted on motor shaft. Motor has high torque-to-inertia ratio, no-load speed of 4700 rpm, develops stall torque of 2.4 oz-in. with power input of 9.2 w per

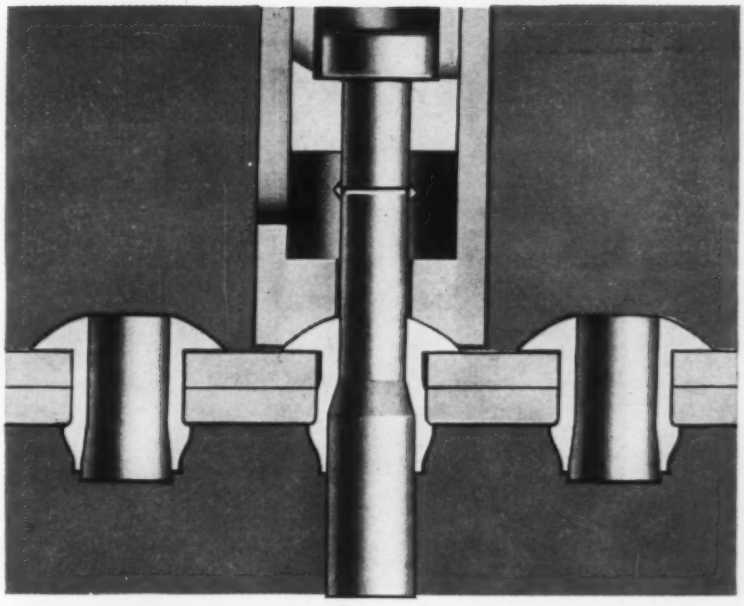
phase, and is rated for continuous duty at stall. Input to tachometer is 115 v 400 cycle. Tachometer output is 3.1 v per 1000 rpm, and linearity is within 0.2 per cent to 5400 rpm. **Avionic Div., John Oster Mfg. Co.**, 1 Main St., Racine, Wis. K

Circle 675 on Page 19

Spring-Steel Fastener

for use in refrigerator freezing compartments

New Speed Nut retains door hinge to freezer compartment and provides necessary spacing for plastic breaker frame to which hinge is mounted. Nut resists high-frequency motor vibration, opening



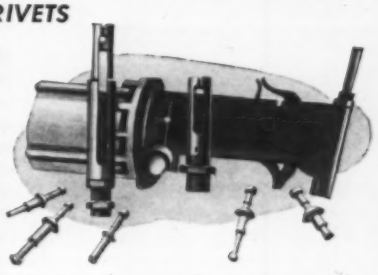
More than a Fastener . . .

A FASTENING SYSTEM

CHERRY RIVETS • VERSA RIVETS

Townsend has engineered blind rivets and setting tools to create a simple, and therefore, economical fastening system. The patented knob stem of the rivet engages a pulling head in the gun which sets the rivet. This head has only two parts, and the rivet is set with a single squeeze of the gun trigger. Engagement of the knob stem is positive and quick even for operators without any special skills.

Pulling heads are extremely durable. The fit between draw-bolt and sleeve is comparatively free, so that wear is slight and tools can be used in the presence of dirt and grit with little danger of clogging. Uninterrupted production, long wear, and negligible maintenance are assured by this simple, sturdy design; and initial tooling costs are low.



Townsend knob stem blind rivets are available in a wide range of sizes and materials in both self-plugging and pull-thru types. Hand, air and electric powered tools can be supplied to meet any production conditions. For full details on the economical Townsend blind rivet system, ask for a demonstration or for Bulletin TL124. Townsend Company, P. O. Box 237-E, New Brighton, Pennsylvania.

The Fastening Authority

Townsend

COMPANY • ESTABLISHED 1816

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Sales Offices in Principal Cities

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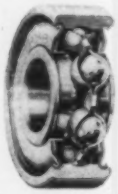
See Townsend blind rivets demonstrated at the DESIGN ENGINEERING SHOW, Booth 971, Chicago, International Amphitheatre, April 14-17

In Canada: *Parmenter & Bulloch Manufacturing Company, Limited, Gananoque, Ontario*

Circle 513 on Page 19

Now you can use "Sealed" Miniature Ball Bearings in the inch size and precision grade YOU *require . . .*



RMB Filmoseal Bearings available in low-cost ABEC-1 as well as ABEC-5 tolerances.

Big news in the miniature bearing field! RMB's famous Filmoseal Bearings—the only sealed miniature bearings—are now made to low-cost ABEC-1 as well as ABEC-5 tolerances. This means designers can use these advanced design bearings even in those slightly less demanding applications where cost is a primary consideration. Designers can take advantage of such features as:

(1) Lubricant retention at high temperatures.
(2) Two-piece ball separators for high speeds.
(3) Coined crown-type ball separators for low torque.

Open radial Conrad-type bearings are also available in this new grade. A wide range of sizes is available from 3/16" (0.1875") to ½" (.5000") OD including many metric sizes.

Write for your copy of the new RMB Miniature Bearings Catalog which gives full details on these as well as the entire line of quality RMB Bearings. Ask for Bulletin 62.

LANDIS & GYR, INC.
45 West 45th Street • New York 36, N. Y.

Circle 514 on Page 19

NEW..."in-line" CONSTANT, HIGH WORKING PRESSURE FILTERS
BRIGGS 0 to 3000 PSI HYDRAULIC FILTERS

SHOCK . . . and vibration take a back seat . . become less of a problem with Briggs new HY-Series Hydraulic Fluid Filters. They are made especially for constant high working pressures.

IF YOU ARE HAVING TROUBLE with sticking valves . . erratic machine performance and if you are looking for full, easy, efficient production, then write for our new bulletin C-26A. It's packed full of complete specs, data you can use and apply . . and scale drawings to help you in your calculations.

IF YOU ARE DESIGNING NEW EQUIPMENT, by all means investigate the many advantages of a hydraulic filter STRONG ENOUGH to take constant punishment, and still deliver top quality production every day.

EXPLODED VIEW SHOWING CONSTRUCTION

HYDRAULIC OIL AND FLUID FILTERS

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PRODUCT OF BOWSER RESEARCH

with interchangeable cartridges for mineral oils, additive oils or noninflammable fluids . . for by-pass, "in-line" or high flow installations.

SEND COUPON FOR BRIGGS NEW BULLETIN C-26A

THE BRIGGS FILTRATION COMPANY, DEPT. 236, WASHINGTON 16, D.C.
SEND BULLETIN C-26A, without obligation, describing your new "in-line" high pressure hydraulic fluid filters.
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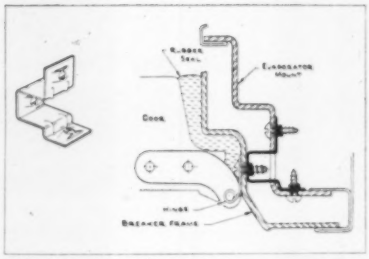
Company_____
Address_____

Circle 515 on Page 19

and closing of doors, and other vibrations, remaining tight until removed. Two nuts per application



are used. **Tinnerman Products Inc.**, P. O. Box 6688, Cleveland 1, Ohio. F

Circle 676 on Page 19

Adhesive Films

for honeycomb sandwich construction

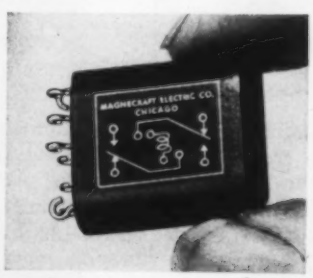
Scotch-Weld bonding films AF-200 and AF-201 consist of a high-strength elastomeric adhesive film on one surface and self-filleting adhesive film on the other. Designed for honeycomb sandwich construction, elastomeric adhesive bonds to facing and self-filleting adhesive to core of honeycomb sandwich panel. Films are for use in temperatures from −70 to 250 F. **Adhesives & Coatings Div., Minnesota Mining & Mfg. Co.**, 411 Piquette Ave., Detroit 2, Mich. H

Circle 677 on Page 19

Miniature Relay

for missiles and missile-guidance systems

Rugged miniature relay provides high resistance to shock, vibration, and temperature, as required in missiles and missile-guidance systems. Oversize instrument-type bearings at both ends minimize hinge friction for increased sensitivity and greater contact pressure. Unit is hermetically sealed and



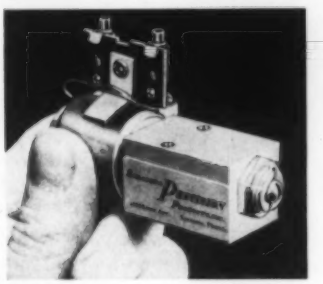
filled with inert gas for maximum protection against severe ambient conditions. Contacts are double-pole, double-throw type. Resistance range is 22 to 5000 ohms and up, power requirement, 500 mw, dc. Weight of unit is 0.35 to 0.55 oz. **Magnecraft Electric Co.,** 3350T W. Grand Ave., Chicago 51, Ill. I

Circle 678 on Page 19

Solenoid Valve

for pilot operation of larger valves

High-pressure, low-capacity, direct-acting solenoid valve, designed for pilot operation of larger valves, can also be used as a direct-acting on-off valve in small hydraulic systems, and for high-pressure lubricating systems. Two or more mounted on a subplate can be used as a three or four-way valve. Hard-



ened, ground, and lapped poppet and seat assure no leakage in off position. Unit is designed for operation to 3000 psi, and delivers 17 cu in. per min at 100 psi pressure drop. Valve handles hydraulic oils, kerosene, or lubricating oils. It is available in 6 to 48 v dc and 110 v ac. **Sarasota Precision Products Inc.,** 1312 N. Lime Ave., Sarasota, Fla. A

Circle 679 on Page 19

Universal Motor

performs over wide temperature range

Model 1-23 precision universal-type brush motor has normalized zinc or aluminum castings to insure accurate fits for dependable performance over wide temperature ranges. Motor can be foot, face, or flange-mounted. Horsepower ratings for continuous duty are 1/30 to 1/5 hp at full-load speeds of 3000 to

You'll find them better for pressure if they're

SHENANGO CENTRIFUGAL CASTINGS

WHATEVER the inside or outside pressures, Shenango centrifugal castings are better able to withstand them without failure.

Parts cast by the Shenango centrifugal process are much tougher because their finer, *pressure-dense* grain avoids stress concentrations while providing greater strength, better elongation and freedom from such costly defects as sand inclusions, blowholes and such.

Whether you need rings, rolls, sleeves, liners, bushings, bearings, mandrels or *any* annular or symmetrical part . . . ferrous or non-ferrous . . . in whatever shape, size or dimension to meet your requirements . . . Shenango can do the job. And do the job *better!*

For informative bulletins on the answers to your tough problems, it will pay you to write now to: *Centrifugally Cast Products Division,* The Shenango Furnace Company, Dover, O.

SHENANGO CENTRIFUGAL CASTINGS

COPPER, TIN, LEAD, ZINC BRONZES • ALUMINUM AND MANGANESE BRONZES
MONEL METAL • NI-RESIST • MEEHANITE METAL • ALLOY IRONS

Circle 516 on Page 19

GEAR-GRIP

The most revolutionary Flexible Coupling Design Development in a century!

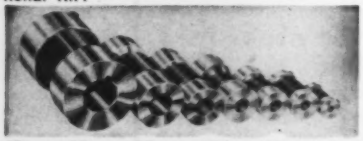
Now available for sub-fractional, fractional and integral H.P.

Ability of rubber Flex-Element to float between captive end fittings distributing load similar to universal joint action.

- Load Ranges—1/12 H.P. through 30 H.P.
- Shaft Sizes—1/8 through 1-7/8.
- Specified exact length to design requirements per series.
- Prevention of end thrust among many other design advancements.

Dyna-Line . . .

The finest flexible coupling in single unit construction—specifically designed for fractional H.P.



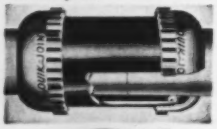
4R 3R 2R 1R 0R 00R

- True Flexibility and Torsional Resilience for quiet, load-plus power transmission without extreme deflection or twist.
- Lengths varied to design specifications in each series.
- Load ranges—1/15 to 1½ H.P.
- Shaft sizes—3/16" to ¾".

Quick-Joint

Steel Compression Pipe Fittings

- UL approved for hazardous fluids.
- Guaranteed for 2000 p.s.i.
- Allows 7° angular deflection.
- No threading of pipe required.
- Special Silicone Gasket for Steam applications.



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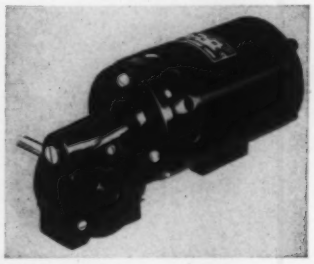
Guardian
PRODUCTS CORP.
COUPLING DIVISION
Dept. M-38
Michigan City, Indiana



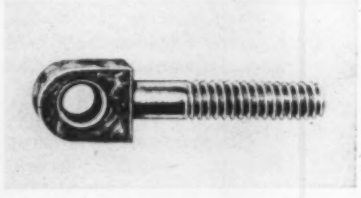
15,000 rpm and range of 24 to 250 v 60 cycle dc. Performance for intermittent duty is 1/30 to ½ hp at speeds of 3000 to 15,000 rpm with range of 6 to 250 v 60 cycle dc. Motor can be used with a new single-reduction gear unit, designated A-26. Highly efficient worm gearing provides maximum power at low speeds, with smooth, quiet operating characteristics. Torques up to 50 lb-in. are available in bronze and bakelite gears, in ratios from 10:1 to 60:1. Gear unit can be detached from motor by removing three external screws. **Howard Industries Inc.**, 1760 State St., Racine, Wis. K

Circle 680 on Page 19

Latch Bolts

in both standard and long lengths

New latch bolts are machined from the solid and cyanide hardened for maximum toughness. They are available in both standard and long lengths with 1/4, 5/16, 3/8, 1/2,



or 5/8-in. thread sizes. **Northwestern Tools Inc.**, 117 Hollier Ave., Dayton 3, Ohio. G

Circle 681 on Page 19

Silicone-Rubber Compound

for high-temperature sealing applications

Silicone-rubber compound 85-138 is a new material for O-rings and custom-molded parts for high-temperature sealing applications. Compound is recommended for tempera-

Dependability at every turn!

SPHERCO

SPHERICAL BEARING & ROD ENDS

Cutaway view of TRE Male Rod End.

Spherco Spherical Bearings and Rod Ends are available in a wide range of units and materials, each designed to meet specific requirements. Spherco design features are found in no other bearings or rod ends on the market. Spherco engineers are always at hand to render service and cooperation.

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A PRODUCT OF
SEALMASTER BEARING DIVISION
STEPHENS-ADAMSON MFG. CO.
18 RIDGEWAY AVE. • AURORA, ILL.

Circle 517 on Page 19

Circle 518 on Page 19

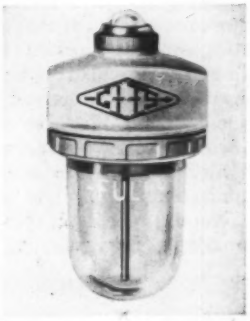
tures to 600 F for short periods of time. It has Shore A hardness of 50, tensile strength of about 800 psi, and elongation of about 250 per cent. **Parker Rubber Div., Parker-Hannifin Corp.,** 17325 Euclid Ave., Cleveland 12, Ohio. F

Circle 682 on Page 19

Air-Line Lubricator

for lines where few adjustments are needed

Pneu-Liner is designed for air-line lubricating applications where few adjustments are necessary once the initial setting is established. Clear dome permits view of operation at all times. Mist action provides constant lubrication during entire period of operation. Unit provides absolute lubrication regardless of



frequency of cycle. Any amount of air from ¾ to 90 cfm can be lubricated by a ½-in. unit. It is adaptable to either right or left-hand mounting without modification. **Gits Bros. Mfg. Co.,** 1850 S. Kilbourn Ave., Chicago 23, Ill. I

Circle 683 on Page 19

Magnetic Latching Relay

miniature unit has high shock and vibration resistance

SL dual-coil, crystal-case-size relay operates on a 1-w, 3 millisecond pulse to either coil and features high shock and vibration resistance. Magnetic latch and high contact pressures hold contacts closed under 100-g shock and 30-g vibration to 2000 cps. Unit switches loads up to 2 amp at 30 v dc resistive or 1 amp at 115 v ac resistive. It is 0.875 in. high, 0.795 in. wide, 0.359 in. deep, and operates in ambient temperatures from −65 to 125 C. Relay can be

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Leroy templates offer a variety of alphabets, sizes and graphic symbols. Electrical, mathematical, mapping, geological and other symbol templates are available. Templates, with words or phrases that are frequently repeated, as well as templates with your own symbols, trade marks or designs, can be made to your order.

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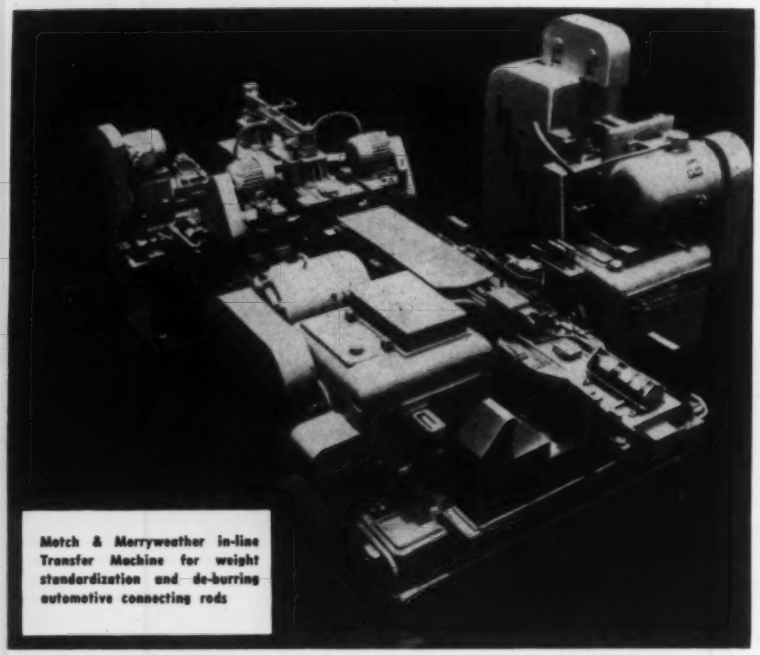
Circle 519 on Page 19



Motch & Merryweather in-line Transfer Machine for weight standardization and de-burring automotive connecting rods

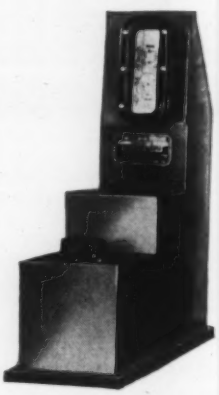
SHADOGRAPH® SCALES

control weight standardization for automated transfer machine

Production of automotive connecting rods increased from 150 to 320 rods per hour . . . quality and uniformity of product improved! These and other benefits are provided by the machine above equipped with Shadograph Scales.

In the machine's fast, automatic cycle, Shadograph Scales first weigh the rods for milling weight bosses on both ends. After milling operations, the rods are checkweighed and accepted or rejected for de-burring.

Exact Weight equipment can be incorporated into any machine that requires accurate control. Complete engineering data is available. Write and give us your specific application.



Shadographs are available in models adapted to your particular needs. Capacities from one gram to 100 lbs.

THE EXACT WEIGHT SCALE CO.
923 W. FIFTH AVE., COLUMBUS 8, OHIO
In Canada: P.O. Box 179, Station S, Toronto 18, Ont.

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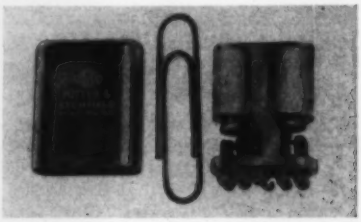
BETTER QUALITY CONTROL . . . BETTER COST CONTROL



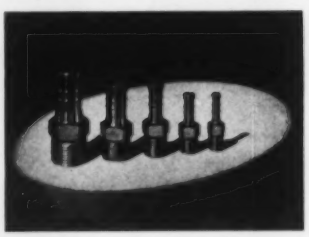
mounted by brackets or studs. It is equipped with plug-in headers or hook-end solder terminals for two No. 24 AWG wires. **Potter & Brumfield Inc.**, Princeton, Ind. J

Circle 684 on Page 19

Hose Nipples

are of Type 316 stainless steel

Hose nipples of Type 316 stainless steel are available in five sizes from ¼ x ¼ to 1 x 1 in. In addition to excellent corrosion characteristics, nipples provide maximum flow, provide greater holding qualities in hose, and extend hose life by minimizing abrasive action of nipple end. Applications include use in high-temperature chemical processing, textile, pulp and paper, rubber, food processing, plastics, atomic energy, refrigeration, food



dispensing, and related industries. **Band-It Co.**, 4777 Dahlia St., Denver, Colo. K

Circle 685 on Page 19

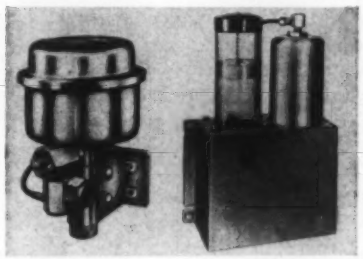
Miniature Lubrication System

for machinery with limited installation space

Accumite miniature lubrication system is for use on machine tools, packaging, canning, labeling, textile, and other similar machinery with numerous bearings and limited installation space. Miniature metering valve services each bearing individually. System handles a variety of lighter-grade lubricants. Four types of pumps, which pressurize system lines and

Circle 520 on Page 19

actuate metering valves, deliver lubricant to service 40 to 200 bearings in one stroke. Pumps include a single-stroke vacuum type (left), a single-stroke air pump (right), air-operated reciprocating unit, and manually operated hand pump. Valves are available in 0.003, 0.006, and 0.009 cu-in. capacities. Components are connected together and



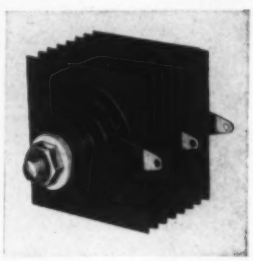
lubricant is distributed through ⅛ or ¼-in. rigid or flexible tubing. **Alemite Div., Stewart-Warner Corp.,** 1826 Diversey Parkway, Chicago 14, Ill. J

Circle 686 on Page 19

Selenium Rectifier

in six cell ratings from 18 to 36 v

New high-current selenium rectifier provides long life, safety and stability at high temperatures, and high dc output efficiency due to low forward voltage drop and low reverse current. Rectifier is available in six cell ratings from 18 to 36 v. Size of the unit has been reduced 50 per cent without



reducing voltage rating. **Electric Products Div., Vickers Inc.,** 1815 Locust St., St. Louis 3, Mo. I

Circle 687 on Page 19

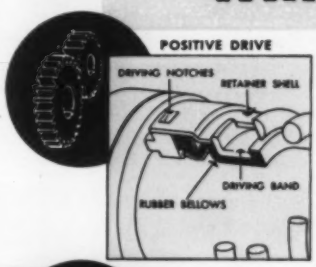
Shim and Gasket Stock

of color-coded plastic

Plasti-Flex is supplied in shims, washers, and gaskets, made to specification, or in roll stock. It is

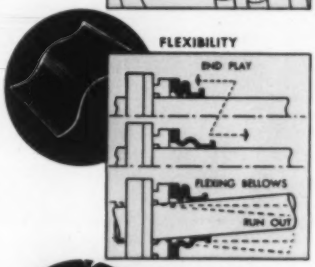
JOHN CRANE

Shaft Seal Design With A Purpose!



POSITIVE DRIVE

This gives long seal life. Drive is transmitted through the driving band and washer driving notch which absorb all breakout and running torque. Damaging stresses on the bellows or flexible sealing member are eliminated. Slippage is also eliminated, thus protecting shaft or sleeve against galling.



FLEXIBILITY

Axial and radial misalignment problems are eliminated. Self-adjusting bellows or sealing head automatically compensates for shaft end play or run out. Minimum spring pressure is required for axial shaft movement and uniform spring pressure is maintained during radial shaft movement.

PRECISION MANUFACTURE

Leakproof performance is assured. Washer and seat surfaces are precision lapped to a perfect mate under a patented "John Crane" process.

A SEAL FOR EVERY SERVICE

All "John Crane" Seals are constructed to the particular service requirements . . . from hot or cold water to the most destructive acids, corrosives and gases . . . temperatures up to 1000°F. . . . pressures to 1200 psi. They can be furnished in types and sizes to meet practically any mechanical or dimensional condition.

Request Bulletin S-204-2. Containing full information on "John Crane" engineered shaft seals.

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Crane Packing Co., 6425 Oakton Street, Morton Grove, Ill. (Chicago Suburb)

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JOHN CRANE

CRANE PACKING COMPANY

Circle 521 on Page 19

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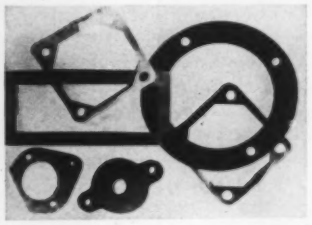


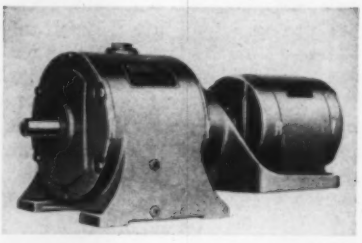
available in gages from 0.001 to 0.030 in., each gage identified by color, permitting selection of size on sight. **Auburn Mfg. Co.**, 300 Stack St., Middletown, Conn. B

Circle 688 on Page 19

Gearmotors

in integral and all-motor types

StraitLine integral and all-motor gearmotors range from 1 to 60 hp and from 9 to 520 rpm. Features include interchangeability of gear sets and motor packages in the field without disconnecting gearmotor from foundation or driven shaft; changing of ratio in the field; gear housing accessible from either end; use of "building block" system of parts standardization.



The all-motor type is shown. **Western Gear Corp.**, P. O. Box 182, Lynwood, Calif. L

Circle 689 on Page 19

Tubing Joint

for high-temperature applications

Conoseal tubing joint connects tubing and ducting of dissimilar metals subject to extreme temperatures. Of all-metal construction, joint has a compression-type metal gasket which achieves excellent flexibility and sealing characteristics. It assures perfect fluid-line seal at temperatures from −300 to 1600 F, at pressures to 6000 psig, and withstands axial

deflections to 1/16 in. Designed primarily for the aircraft and guided missile fields, joint is suitable for high-pressure pneumatic systems, liquid oxygen, hydraulic, exhaust, and fuel systems. It is available in low, medium, and high operating ranges in standard tube

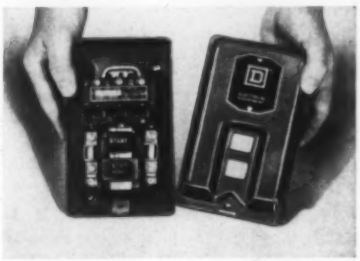
sizes from 1 to 12 in. OD. **Marman Div., Aeroquip Corp.**, 11214 Exposition Blvd., Los Angeles 64, Calif. L

Circle 690 on Page 19

Manual Starters

for control of motors to 7½ hp

Class 2510 integral-horsepower manual starters, in NEMA size 0 and 1, are for control of motors to 7½ hp. Heavy-duty, toggle-action operating mechanism gives positive snap-action opening and closing of contacts, with no dead-center position. Rated to 600 v ac or 250 v dc, starters are available in two, three, or four-pole construction. Pressure wire connectors are pro-



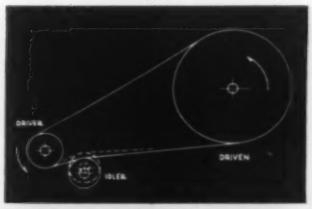
vided on all wiring terminals. **Square D Co.**, 4041 N. Richards St., Milwaukee 12, Wis. K

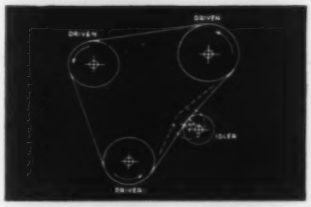
Circle 691 on Page 19

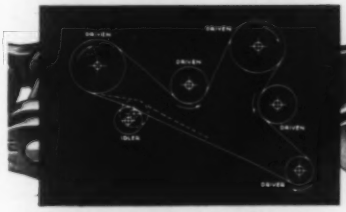
Drain Valve

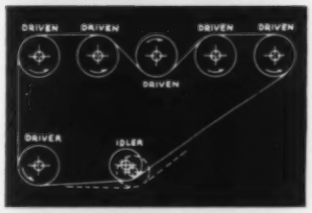
for pressurized air ducts

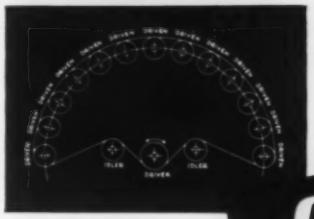
Self-operating drain valve reduces corrosion in pressurized ducts by removing water as it accumulates











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Circle 523 on Page 19

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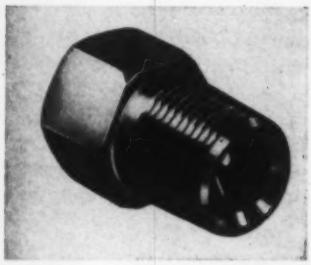


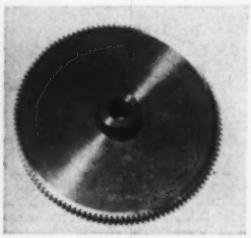
in low spots. Tungsten-carbide ball inside stainless-steel body blocks valve opening and is held in place by duct pressure. When duct pressure is reduced below 10 psi by system shut-off, a spring forces ball out of valve opening and allows water to drain. Increase in duct pressure forces ball back into closed position. Maximum temperature is 1200 F, maximum pressure, 600 psig at 570 F. **Aircraft Controls Div., Barber-Colman Co.**, 1400 Rock St., Rockford, Ill. K

Circle 692 on Page 19

Spur Gears

in six pitches from 48 to 200

Type P2 AGMA Precision 2 spur gears are furnished in stainless steel, aluminum, nylon, and phenolic. Materials and finishes meet MIL specifications. Six pitches



from 48 to 200 are available. **PIC Design Corp.**, 477 Atlantic Ave., East Rockaway, L. I., N. Y. D

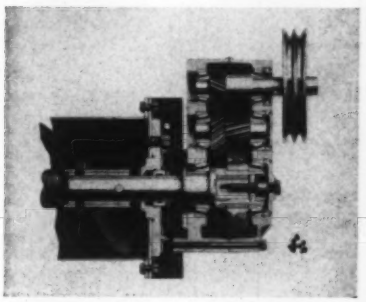
Circle 693 on Page 19

Speed Reducer

incorporates heat-treated steel helical gears and pinions

New drive, for use in mixing equipment, conveyors, and similar equipment, consists of a speed reducer with packing gland and driving shaft. Heat-treated steel helical gears and pinions provide maximum efficiency. Design of the

drive insures protection for speed-reducer unit against invasion by foreign material being handled. Packing gland is adjustable from the outside, takes standard packing, and can be inspected by sight. Flinger seal on the shaft next to the reducer also prevents liquids or other foreign matter from reaching reducer seals. Third barrier against contamination is provided by double-lip reducer seals. Slotted



holes in flange of reducer permit unit to be rotated for quick and easy adjustment of V-belt drive center distance. Motor and drive can be mounted in any position. Drive is available in four sizes, each size being offered in two ratios—18:1 and 8:1. **Dodge Mfg. Corp.**, Mishawaka, Ind. J

Circle 694 on Page 19

Solenoid Valves

provide bubble-tight sealing

SV-4900 solenoid valves incorporate a soft rubber plunger seal which assures bubble-tight sealing. They can be operated in any position. Units are 2.35 in. high x 1.50 in. wide, with 7/64-in. orifice rating of 130 psi max and 5/32-in. orifice rated 60 psi max. Valves are for general use with water, air, steam, inert gases, petroleum and vege-

MANZEL

accurate, controlled, timed lubrication

Get the automatic, timed lubrication you need to protect valuable machinery, eliminate downtime, cut maintenance costs. Wide range of Manzel Lubricators and controls, in single and multi-feed units, will solve any lubrication problem. A Manzel field engineer will help select the model you need.

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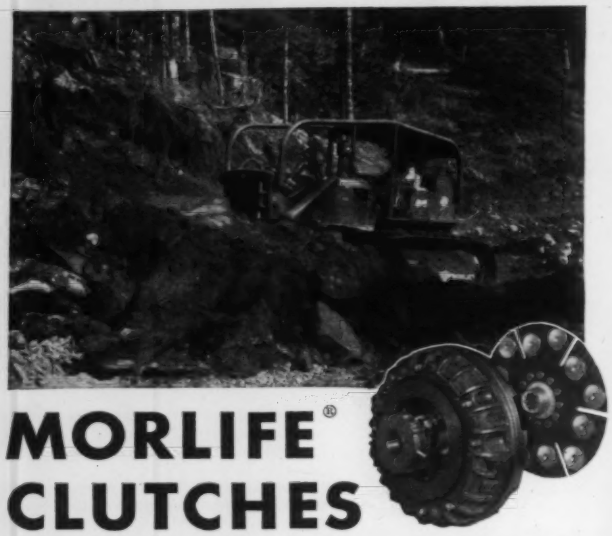
Circle 525 on Page 19

ROCKFORD



Small Spring Loaded

Automotive Spring Loaded

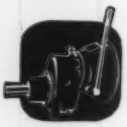
Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Light Over Center

Power Take-Offs



Speed Reducers

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Control Power Better in the Heaviest-Duty Machines

ROCKFORD Over-Center CLUTCHES, equipped with MORLIFE clutch plates, provide 100% more torque grip than previous type clutches of equal size. This permits the use of smaller diameter clutches. Easier operation is accomplished by reducing the required engaging pressure. 50% better heat disposal avoids down-time caused by burned or warped plates. Numerous field records prove that MORLIFE clutches operate 400% longer without plate replacement or adjustment. Let these NEW type clutches help improve the operation of *your* heavy-duty machines.

SEND FOR THIS HANDY BULLETIN

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

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Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

ROCKFORD B-W BORG-WARNER

CLUTCHES

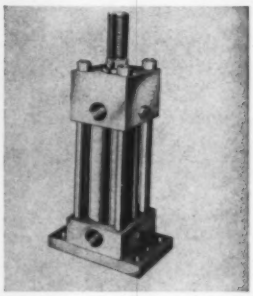
table oils, gasoline, kerosene, and other semicorrosive media. **Valcor Engineering Corp.**, Dept. 717, Carnegie Avenue, Kenilworth, N. J. D

Circle 695 on Page 19

Cylinders

for heavy-duty applications

Improved heavy-duty actuator cylinders are rated at 200 psi air



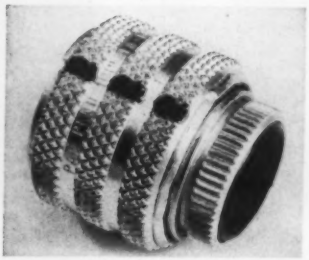
and 1000 psi oil. Cylinders have applications in the automotive, machine tool, rubber, plastics, lumber, and other industries. **S-P Mfg. Corp.**, 30201 Aurora Rd., Solon, Ohio. G

Circle 696 on Page 19

Miniature Connector

has large gripping surface

Miniature electrical connector incorporates a long, heavily knurled coupling ring which provides a large gripping surface. Coupling ring has no step-down. It is avail-



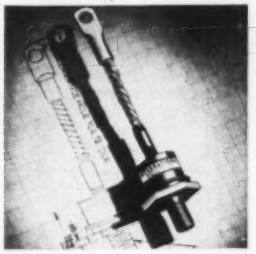
able in all miniature electrical connector sizes. **Deutsch Co.**, 7000 Avalon Blvd., Los Angeles 3, Calif. L

Circle 697 on Page 19

Silicon Power Rectifiers

of fused-junction type

Silicon power rectifiers meet requirements of MIL-E-1 and MIL-



T-19500-A. Three units are available, one rated at 35 amp rectified dc output current with PIV rating of 100 v, and the other two rated at 35 amp with PIV voltage ratings of 50 and 200 v. Fused-junction type rectifiers with welded, hermetically sealed construction are for application to all types of military equipment. They are reliable under extreme environmental conditions of moisture and humidity, shock, vibration, centrifugal forces, and temperature cycling. **International Rectifier Corp.**, 1521 E. Grand Ave., El Segundo, Calif. L

Circle 698 on Page 19

Elapsed-Time Indicator

for either 120 or 240 v

Elapsed-time indicator is available with three case styles—3½ in. round, 3½ in. round shroud, and 3½ in. rectangular. Unit is built around a self-starting, synchronous clock motor, and is made for either 120 or 240 v. Auto-resetting counters read either 0 to 99999 or 0 to 9999.9 hr. **Simpson Electric Co.**, 5200 W. Kinzie St., Chicago 44, Ill. I

Circle 699 on Page 19

Rod-End Bearing

incorporates
integral connecting stud

Alinabal spherical-bearing rod-end bearing with integral connecting stud can be misaligned up to 35

Circle 527 on Page 19→

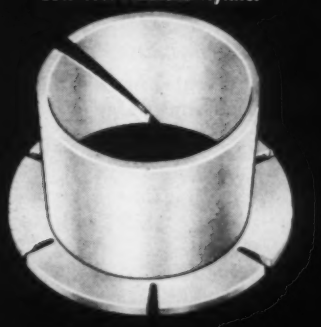
THOMSON

NYLINED®

BEARINGS

REDUCE COSTS-
ELIMINATE
LUBRICATION

Low Cost FLANGED Nyliner®



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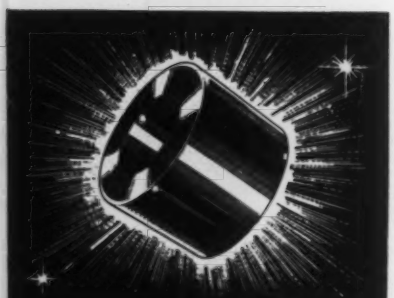

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LOW FRICTION

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BUSHINGS

EXCELLENT DURABILITY • CONSTANT COEFFICIENT OF FRICTION • APPLICABLE OVER A WIDE TEMPERATURE RANGE (−450° to +700°F.) OPERATE DRY, OR AT HIGH SPEEDS SUBMERGED IN WATER, GASOLINE OR LIQUID GASES • NON-CONTAMINATING IN FOODSTUFFS • EXCELLENT FOR CURRENT-CARRYING BEARINGS

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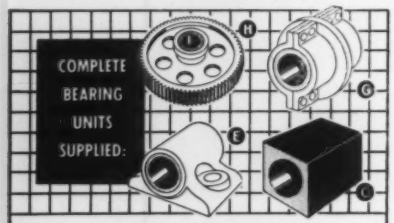

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GRAPHALLOY has high-performance electrical properties: *low electrical noise, low and constant contact drop, high current density, minimum wear!*

Brush Holders and Assemblies, Coin Silver Slip Rings and Assemblies available.

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☐ Please send data on Graphalloy Oil-Free BUSHINGS.

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NAME & TITLE

COMPANY

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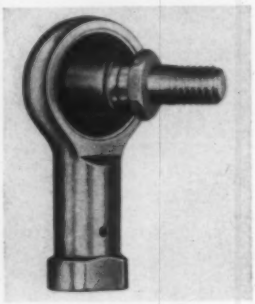
Circle 528 on Page 19

deg in any direction. Ability to swivel at maximum misalignment for full 360 deg makes it suitable as a connector for any type of misaligned linkage or control rod. Rod ends with integral stud are avail-



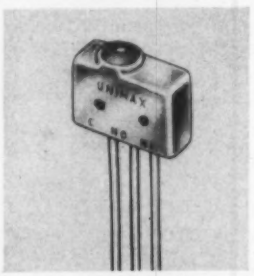
able in four sizes in both male and female types. Standard stud diameters are ¼, 5/16, ⅜, and ½ in. Stud lengths, from center of ball, are 1 1/32, 1 7/32, 1 9/16, and 2 in. **Carter Engineering Co.**, Ferrysburg, Mich. H

Circle 700 on Page 19

Subminiature Switch

is sealed against dust, oil, and water

Type EA 1 subminiature, environment-free switch is effectively sealed against entrance of foreign matter. Operating element is enclosed in a housing of corrosion-resistant treated aluminum, and embedded in epoxy resin. Elastomer seal permits free movement of pin but keeps dirt and moisture out of switch. Unit is furnished with



three insulated wire leads to specified length, or with wire-loop terminals. Electrical rating is 5 amp 125/250 v ac; 5 amp 30 v dc resistive; 2½ amp 30 v dc inductive. **Unimax Switch, Div., W. L. Maxson Corp.**, Ives Road, Wallingford, Conn. B

Circle 701 on Page 19

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"Directory of Materials"

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ENGINEERING DEPARTMENT

EQUIPMENT

Gear-Train Analyzer

measures lost motion in precision gear trains

Gear-train analyzer, particularly adaptable to high-ratio gear trains having small input torques, evaluates lost motion in precision gear trains in servo units, computers, and guided missiles. Unit consists of an electronic control console and two-phase torque actuator. Torque actuator is substituted for motor drive of gear train to be checked. Total lost motion is measured by applying constant torque to input pinion of locked gear train and reading clockwise and counterclockwise actuator-shaft displacement. Unit also measures

torque required to drive free-running gear boxes, facilitates adjustment of gear meshes and bearing alignments during assembly, and provides a means of setting gear-train safety clutches. It can be used for testing gear trains under various environmental conditions. Analyzer operates on 115-v, 60-cycle supply. **Daco Instrument Co.**, Tillary & Prince Streets, Brooklyn 1, N. Y. D

Circle 702 on Page 19

Electrical Pencil Pointer

provides acute angle on drawing pencil leads

Point-O-Matic electrical pencil pointer contains a small synchronous motor which directly drives a fine sanding disc. Disc is permanently oriented to provide an acute

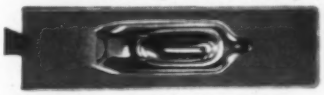
MICRO SWITCH Precision Switches

A NEW HONEYWELL MERCURY SWITCH

Sealed Within Nylon Enclosure
•
Shock-Proof
•
Resistant to Oil and Water

7MP1-2 Actual Size

Cut-away view showing switch embedded in synthetic rubber within the nylon enclosure.



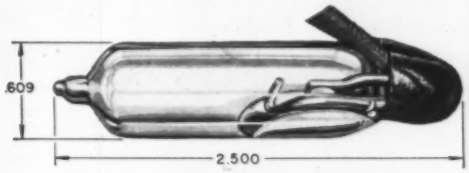
This NEW mercury switch is resistant to shock, vibration, water, alkalis and oils. Operates completely immersed. Operates at temperatures of from −35° to +200°F. Rated 3 amps., 115 vac. *For complete details send for Data Sheet #144.*

Meets Demand for Small Load Circuits

AS417B Actual Size

This small Honeywell Mercury Switch meets the demand for small load circuits and applications where space is a factor. Serves in a range from micro-volt milli-ampere up to 3 ampere circuits. *Full details in Data Sheet #114.*

Here is a General Purpose Mercury Switch



AS454A Actual Size

This is a medium size, general purpose mercury switch for loads up to 10 amps., 115 vac. Whenever your requirements call for general advantages such as sealed contacts and low force tilt action, this is the switch for you.

Ask for Catalog #90A.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

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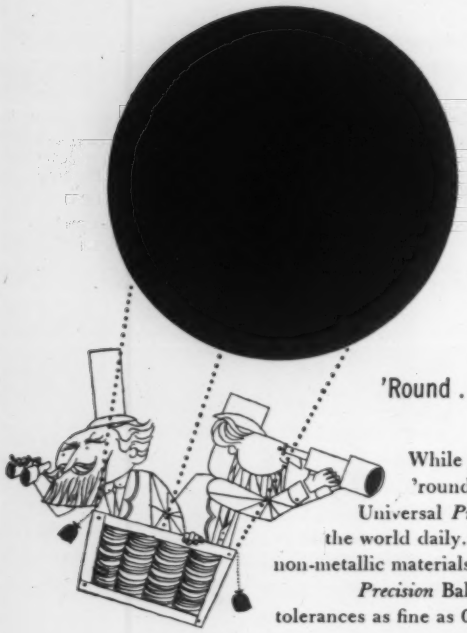
First in Precision Switching

Circle 530 on Page 19



'Round . . . in less than 80 days!

While Jules Verne sent Phileas Fogg 'round the world in 80 days, Universal *Precision* Balls are found 'round the world daily. Whether metallic or non-metallic materials are specified, Universal *Precision* Balls are quality controlled to tolerances as fine as 0.000005 of an inch.

Round? Yes! If they are Universal Precision Balls.

UNIVERSAL QUALITY CONTROL—FOR ALL AROUND PERFECTION

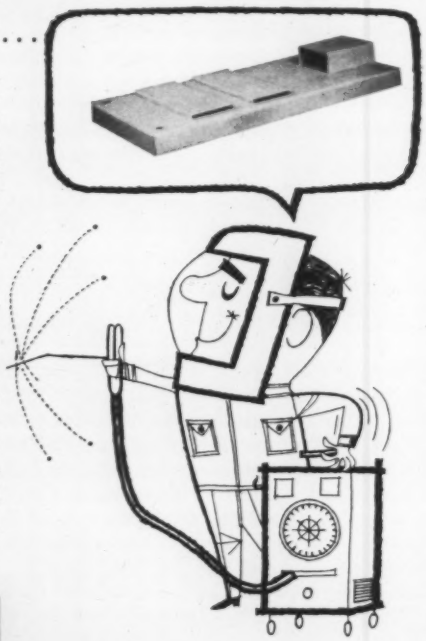
Universal Ball co.

WILLOW GROVE, MONTGOMERY CO., PA.

Circle 531 on Page 19

We can fabricate anything but fosses

Frankly, we haven't even tried . . .



After all, we must be reasonable. A foss is a ditch, trench, canal or moat. How could we lay out, shear, punch, bend, flame cut or assemble a canal? How could we weld, stress relieve, sand blast or machine a moat? It isn't being done these days.

In the field of weldments, Littleford is on solid ground, 175,000 sq. ft. of it actually, loaded with modern fabricating facilities manned by 300 skilled craftmen. Littleford weldments save your time, equipment and money. Send today for your free copy of our new 16-page catalog—it's free. Better still, send us your blueprint for prompt estimate.

LITTLEFORD

Littleford Bros. Inc., 512 E. Pearl St., Cincinnati 2, Ohio

Circle 532 on Page 19

angle on drawing pencil leads. Pencil admittance hole contains a spring-loaded switch, which operates motor when pencil is inserted and turns motor off when pencil is withdrawn. Unit sharpens leads of either semiautomatic mechanical drawing pencils or of wooden pencils which have been first turned down in draftsman-type pencil sharpeners. Sanding discs are held in place by a permanent-magnet chuck, and are replaced easily. Unit provides conical, chisel, or eliptical-point finishes. **Johnson Mfg. Co. Inc.,** 137 Main St., Monroeville, Ind. J

Circle 703 on Page 19

Punched-Tape Programmer

controls up to 85 individual circuits

Punched-tape programmer uses vinyl tape which makes available 85 individual load circuits. For each foot length of tape there are 64 possible ste nd step or position quantity is limited only by length of roll of tape. Available with the unit are memory load relays, actuated by a pulse transmitted through punched hole in tape. Circuit remains energized until second pulse is transmitted through a subsequent hole in the same channel in the tape. All circuits can be returned to normal at end of cycle or in any position as required. Unit is self-homing and equipped

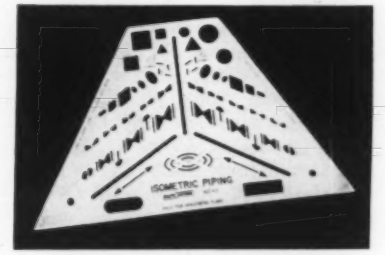
with indicating lights for steps in the program and pilot lights for each load circuit. Programs can be changed rapidly and easily by insertion of a different tape. **Industrial Timer Corp.**, 1407 McCarter Highway, Newark 4, N. J. C

Circle 704 on Page 19

Template

for isometric piping layout drawings

No. 43 isometric piping template is designed for isometric piping layout drawings. It contains symbols for depiction of components of piping systems, including valves, flanges, elbows, reducers, caps, and pumps. Template can be tilted three ways, permitting fast, accu-



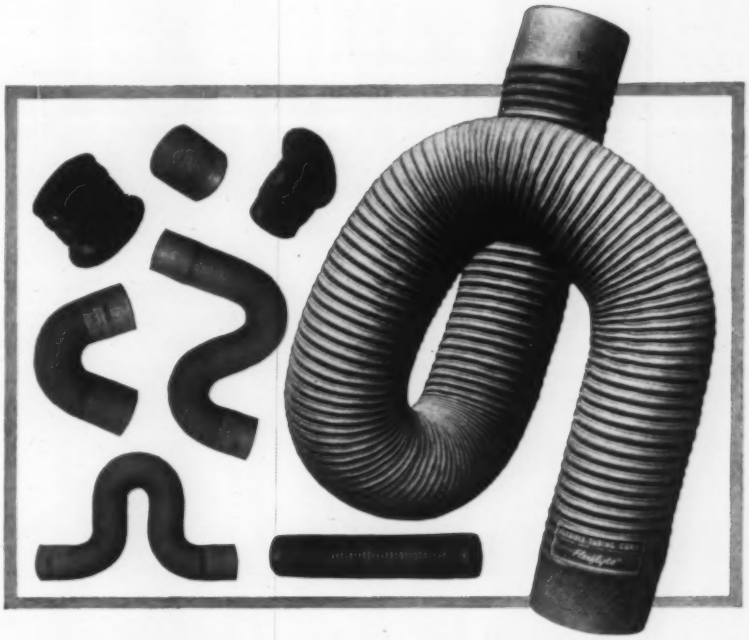
rate drawing in the three planes of a perspective view. Made of 0.030 mathematical quality plastic, template is milled for smoothness of line. Overall size is 8½ x 5¼ in. **Rapidesign Inc.**, Box 429, Burbank, Calif. L

Circle 705 on Page 19

AC Voltage Regulator

provides five sensing arrangements

Model APR1010 is a tubeless all-purpose ac voltage regulator which regulates average and peak voltages as well as rms, independent of input waveform. Five different sensing arrangements are provided: Internal (normal ac regulation), external ac (any ac voltage), remote (115 v ac at a remote location), constant current, and dc. Terminals are provided at rear of unit to enable 0.1 per cent ac load-regulation accuracy to be held at a remotely located load. Unit features 3 per cent maximum harmonic distortion, 0.2-sec recovery with line changes and 0.1-sec recovery with load changes, rapid

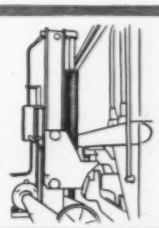


Here's why so many of today's specs call for FLEXIBLE TUBING products

Flexible Tubing has a thorough understanding of industry's ducting needs. Close collaboration with design engineers and trouble-shooting trips—hundreds and hundreds of them—have familiarized our engineers with countless ducting problems. Each successive job we've tackled has added to our knowledge of ducting behavior. And over the years we've acquired the facilities and equipment needed to meet any requirement. We now have completely integrated plants for development and production on both coasts.

Our present line of flexible ducting is the most complete, most diversified in the industry and we're always prepared to vary or modify any part of it. In the panel below we mention several recent applications for Flexflyte and Spiratube—lightweight ductings available with special fabrics and coatings for a wide range of temperature and pressure applications.

The background and experience of our field engineers are at your service. Let us know your requirements and we'll be glad to have one of them stop by to talk over your problems. For full information, write Dept. 183.



Example

Spiratube used as protective covering on actuating screw of railroad car boot jack.

Other typical applications

Flexflyte: feeder tubes for gluing machines; organ piping connections; sander tubes for railroad cars; connector ducts from abrasive wheels to dust collectors on buffing and tire-truing machines.
Spiratube: crop drier hose; for dust collecting from multiple drill rig; for venting cooling air from diesel locomotives.

Flexible Tubing

CORPORATION

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Circle 533 on Page 19

The **TIMER RELAY**
that handles all controlled timing problems . . .

This steel clad, factory set, tamper proof Durakool timer-relay is practically non-breakable. Operating life multiplied 5 to 6 times by new plunger construction features. Combinations of operate-release time delays from 0.15 sec. to 20 sec.—either normally open or normally closed action.

Durakool
STEEL MERCURY TIMERS

- ★ No false contacts
- ★ Non sticking
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- ★ Low cost timer

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Circle 534 on Page 19

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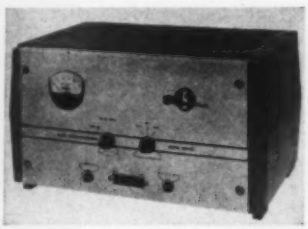


starting, 0.04 per cent drift in 24 hr and 0.1 per cent drift in 1000 hr. Cabinet or rack-mounted models are available. **Sorensen & Co. Inc.**, Richards Avenue, South Norwalk, Conn. B

Circle 706 on Page 19

Spur-Gear Kits

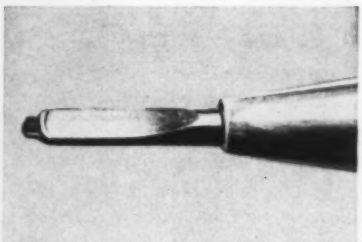
for mockups and breadboard use

Type CT spur-gear kits, containing AGMA Precision I, II, or III gears, have been designed for use in breadboards, mockups, experimental, and prototype applications. Gears, available in 48, 64, 72, 96, and 120 pitches, are stainless steel and aluminum. Kits contain a variety of gears, shafts, collars, couplings, and clamps. **PIC Design Corp.**, 477 Atlantic Ave., East Rockaway, N. Y. D

Circle 707 on Page 19

Drawing Pencil

uses flat-ribbon lead inserts



Constructor flat propelling drawing pencil uses flat-ribbon lead inserts only 0.016 in. thick and 0.047 in. wide (shown). Hard rubber knurled shaft permits easy handling. New lock-clutch provides nonslip lead grip. Top of pencil is stamped and various colored rings are supplied for instant recognition of different grades of lead hardness. **Alvin & Co.**, 853 Palisado Ave., Windsor, Conn. B

Circle 708 on Page 19

THE ENGINEER'S

Library

Recent Books

Mechanical Refresher for Professional Engineers License. *By John D. Constance; 59 pages, 8½ by 11 in., paperbound; published by and available from John D. Constance, 625 Hudson Terrace, Cliffside Park, N. J.; $3.00 per copy.*

This mechanics and machine-design refresher is intended for candidates who are preparing for an examination for the professional engineer's license. Contents have been expanded and rewritten to be of use to engineers in all states. New material covers mechanical vibration, impulse and momentum, friction, dynamics of a particle, and work and energy.

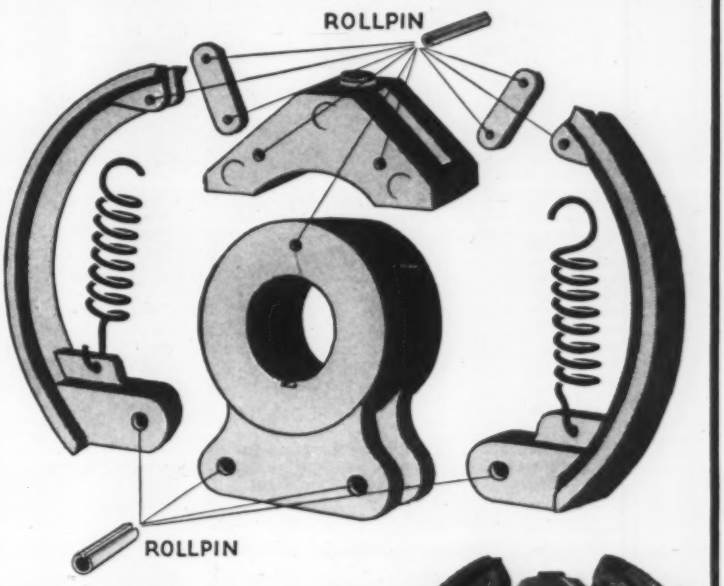
Also included are vectors, kinematics, plane curvilinear motion, belt transmission of power, gearing, lubrication, and cylinder design. Problems and solutions are included for each topic.

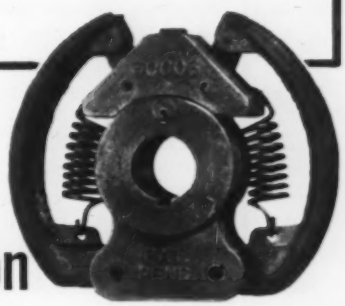
Automation and Management. *By James R. Bright, Graduate School of Business Administration, Harvard University; 270 pages, 8½ by 11 in., clothbound, published by and available from Division of Research, Harvard Business School, Soldiers Field, Boston 63, Mass.; $10.00 per copy.*

This entire study has been directed toward answering the question of whether highly automatic manufacturing systems have created new and different problems for management. Three major sections of the book cover the nature of automatic manufacturing, experiences with mechanization, and critical areas of automation.

Contents include evolution of automation, qualities of mechanization, thirteen automation programs and their backgrounds and techniques, conception and design of automation systems, maintenance and management of downtime, problems with personnel, and im-

FASTENER PROBLEM





Rollpin use eliminates reaming operation

When the Lombard Governor Corporation engineers designed a new centrifugal clutch for Lombard chain saws, they faced a fastening problem: What fastener would provide simple, inexpensive assembly operations yet be strong enough and dependably secure under rugged service conditions?

Rollpin was the answer. A hollow, slotted spring type pin, oversize in relation to standard production-drilled holes, it is readily pressed into position, automatically locking itself in place through pressure on the hole walls. Lombard found that use of Rollpins eliminated a reaming operation—effecting an important saving in production costs—and performed without failure in the field.

Removal and re-use is easy, too. Rollpins can be easily driven out with a punch, and hammered back in again with equal ease. Unlike rivets, they require no secondary locking operation, and their heat-treated spring action provides extended re-usability.

If you use taper pins, set screws, rivets, hinge pins or any other pin type fastener, consider redesigning with Rollpin for simplified assembly operations at lower cost.

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Elastic Stop Nut Corporation of America
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Circle 537 on Page 19

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pact of automation on sales. A final chapter sums up ten significant trends of current automation and their effects on the factory.

Introduction to Heat Transfer. *By Aubrey I. Brown and Salvatore M. Marco, The Ohio State University; 332 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$6.75 per copy.*

This third edition has been revised to include symbols and notation which conform to American Standards. New chapters on fluid flow in convection processes and on graphical and numerical methods for heat conduction problems have been added. New material on fundamental units is intended to clarify interchanging of force and mass units in equations.

Contents cover modes of heat transfer, dimensional analysis, heat transfer to boiling liquids, application of heat-transfer principles to design problems, and heat transfer as related to electrical-transformer design problems.

Association Publications

The American Welding Society Bibliographies. *8½ by 11 in., paperbound; published by and available from American Welding Society Inc., 33 West 39th Street, New York 18, N. Y.; set of 28 bibliographies $5.00; single bibliographies 50 cents per copy.*

This set of bibliographies of articles which has appeared in the *Welding Journal* during the last 20 years covers practically every welding process, metal, and material. Individual bibliographies are grouped according to the following classifications and are listed for the year during which they appeared:

Aircraft; Aluminum; Brazing; Cast Iron; Copper and Copper Alloys; Destructive Examination in Welding; Electrodes and Welding Rods Including Their Coverings and Fluxes; Flame Hardening and Flame Softening; Inert Gas and Metal-Arc Welding; Inspection and Non-destructive Examination; Machinery Construction; Magnesium;

Metallizing; Molybdenum and Zirconium; Nickel and Nickel Alloys; Oxygen Cutting, Gouging, and Machining; Piping and Tubing; Railroad; Pressure Vessels and Storage Tanks; Resistance Welding; Safety in Welding; Ship Construction; Stainless Steel; Structural; Submerged-Arc Welding; Surfacing; Titanium; and Training, Qualification of Procedures and Welders, in the welding trade.

Toward the Factory of the Future, Special Report No. 28. 96 pages, 6 *by* 9 *in., paperbound; published by and available from American Management Association Inc.,* 1515 *Broadway, Times Square, New York* 36, *N. Y.;* $1.75 *per copy to members,* $2.50 *per copy to nonmembers.*

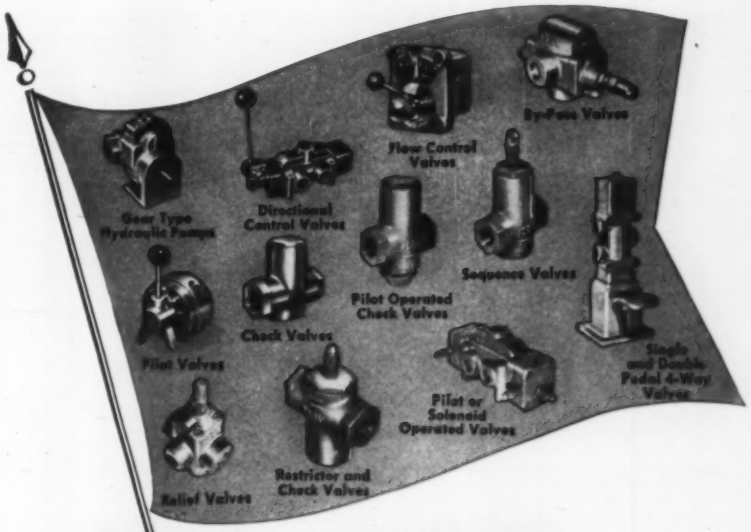
This report is intended to help manufacturing management prepare for a smooth transition from present to future techniques and facilities of manufacturing operations. It offers managers a guide by which advancements of their own companies can be measured and aids in establishing goals for further progress.

Topics discussed include the challenge of change, maintenance operations in the factory of the future, research and development, the purchasing agent of the future, impact of atomic energy on production processes, automation for the smaller company, and developing tomorrow's leaders.

Designing Parts for Cold and Hot Heading. 95 *pages,* 7 *by* 10 *in., clothbound; published by and available from Industrial Fasteners Institute,* 1517 *Terminal Tower, Cleveland* 13, *Ohio;* $2.00 *per copy.*

This first edition is intended to familiarize design engineers with the economies and design techniques of heading small parts. Included are data on the process and materials used, design studies of headed parts, and rules for designing parts for economical production by heading.

Contents include machines and processes, heading design, designing for secondary operations, drawings and specifications, effect of plating on dimensions, and tables of conversion factors, thread series, and corrosion data.



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Russ Chamberlin Company
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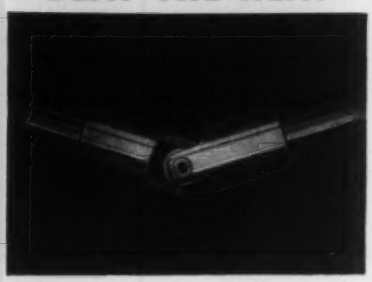
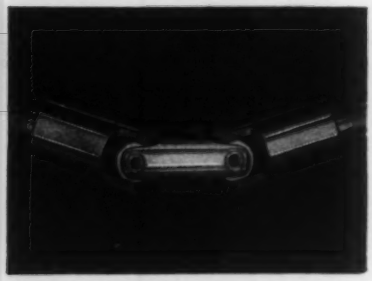
Circle 539 on Page 19

How Curtis helped a design engineer "BEAT THE HEAT"



This single universal joint in a ribbon-stripping machine was operated at a 34° angle. The joint heated up, wear was excessive. (Curtis Joints have been tested at angles up to 37°, but we do not ordinarily recommend angles greater than 30°.)



Curtis engineers recommended a *double* Curtis joint, which reduced the angle to 17° per joint. Result: no overheating, improved efficiency, longer life.

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because our catalog torque and load ratings are substantiated by constant tests under production conditions.

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Circle 540 on Page 19

Government Publications

Wright Air Development Center Technical Reports. *Each publication is 8¼ by 10¾ in., paperbound, and stapled; copies are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.*

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Circle 541 on Page 19

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This report is based primarily on an extensive literature survey. Topics discussed include effects of increased equipment complexity, distribution of causes of failure, and design techniques.

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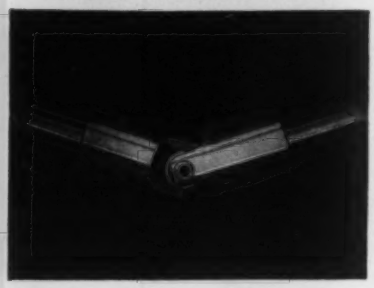

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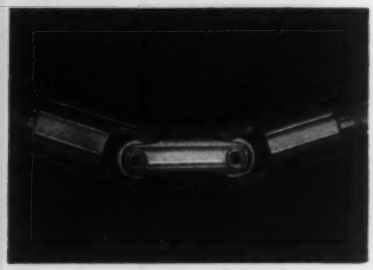

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Circle 541 on Page 19

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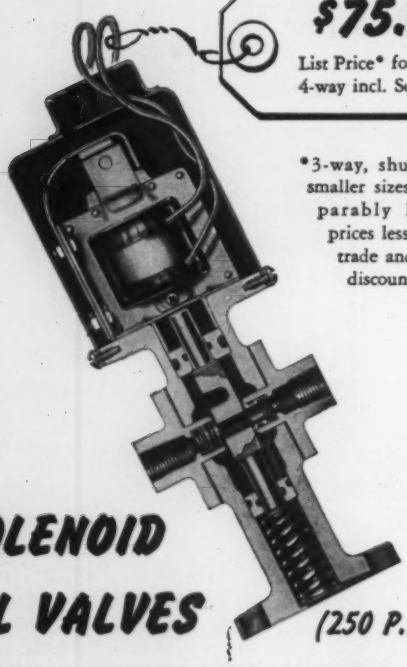
$75.00
List Price* for a ½" 4-way incl. Solenoid



*3-way, shut-off and smaller sizes are comparably less. All prices less the usual trade and quantity discounts.

SOLENOID OIL VALVES (250 P.S.I.)

WHERE	WHY	HOW
Thread rolling machines	Holding position (leakproof)	Lapped sealing surfaces seal tight indefinitely as a result of wear compensation
Pressure testing in automotive production	Oil gets contaminated by scale in castings (not critical to dirt) reduced maintenance	Sealing surfaces in constant, intimate contact, dirt can't lock valving members – saves coil burn-out
Hydraulic work feed apparatus	(Leakproof) ... as versus spool valves which cause overdemand on hydraulic system	Positive shut off of internal port to port leakage and of course, no external leakage
Machine tool chucking & clamping	Maintaining safe holding pressure (leakproof)	Saving auxiliary equipment such as pilot operated check valves
Automatic door openers	Quick action (high flow capacity)	No spools or poppets obstructing full, round flow passages
Solenoid controlled hydraulic system on machine you build	Better performance Lower manufacturing costs Reduce service problems	Shear-Seal valves have full flow, are leakproof, not sensitive to dirt Low priced, less auxiliary equipment and labor cost. Valves don't stick, saving coil burn-out; stay leakproof indefinitely, seals are wear compensating

BARKSDALE VALVES

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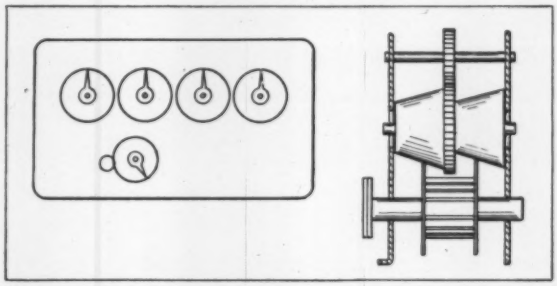
NOTEWORTHY

Patents

Temperature-Compensated Variable-Ratio Drive

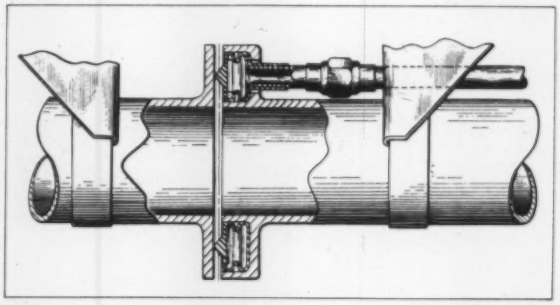
Reduction ratio changes with temperature in a variable-ratio drive designed for use in gas-flow measuring instruments. By compensating for gas temperature—and, therefore, gas density—the drive converts a volume-flow measurement to a meter reading that is proportional to the actual heat units contained in the gas. Principal components in the assembly are a driven double-cone pulley and a pair of thin,



friction drive pulleys which are mounted on an axially movable shaft. Translation of the drive-pulley shaft, which changes the reduction ratio of the drive, is accomplished by a bimetallic element. Contact between driving and driven pulleys is maintained by a permanent magnet which serves as a spacer between the thin, soft-iron drive pulleys. *Patent* 2,817,242 *assigned to American Meter Co. Inc., Erie, Pa. by Robert B. Gray.*

Inflatable-Seal Pipe Coupling

Need for external clamps or fasteners is eliminated, in a quick-disconnect pipe coupling employing an inflatable seal ring. Unit seals when pressure from a



remote source expands the annular seal bladder, forcing the wedge-shaped sealing rib into contact with the facing flange. Seal effectiveness is not destroyed by reasonable nonaxial misalignment between conduit

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Circle 544 on Page 19→

DOW CORNING CORPORATION

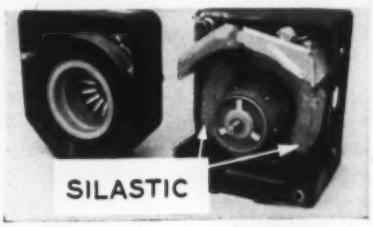
Silicone News

FOR DESIGN ENGINEERS No. 48

Vital Strip Heaters Are Sandwiched in Silastic

Fighter pilots had gun cameras to record their hits and misses during World War II, but how do today's pilots keep score against mere radar "blips"? The answer is Nadar, developed by the Autonetics Division of North American Aviation. And Silastic*, the Dow Corning silicone rubber, helps keep Nadar units at proper working temperatures.

An ingenious electro-mechanical system, Nadar automatically keeps tabs on hits and misses by recording the radar images on four-channel magnetic tape. Without auxiliary heat, however, Nadar would have a minimum operating temperature of only 41 F, far above the required —80 F encountered at high altitudes and in Arctic service. That's why each unit contains three strip heaters bonded between sheets of Silastic coated glass cloth. Custom-

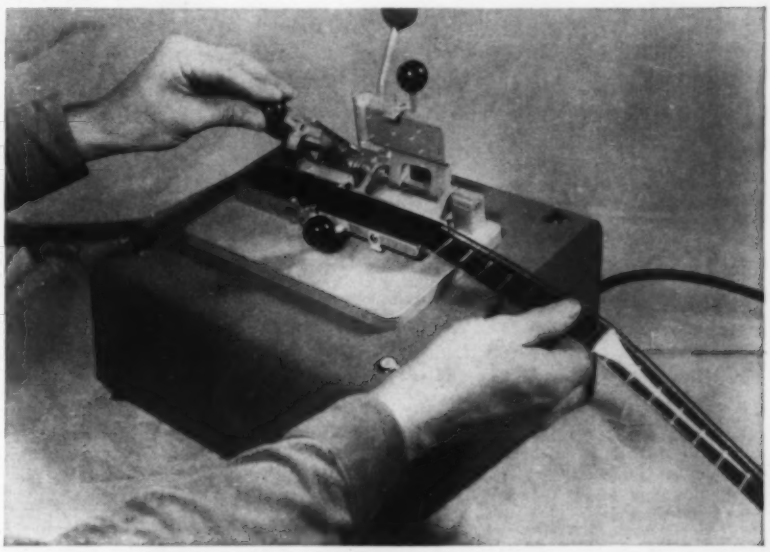


designed by Electro-Flex Heat, Inc., the heaters utilize up to 100 watts each and raise temperature from — 80 F to + 41 F within 15 minutes.

Silastic was selected as insulation for the strip heaters because it has the thermal stability to withstand the sudden and severe temperature changes encountered in this application. It won't harden, crack or check at temperatures ranging from —130 to over 500 F. In addition, it has excellent

* T. M. REG. U. S. PAT. OFF.

(Cont. Pg. 2)

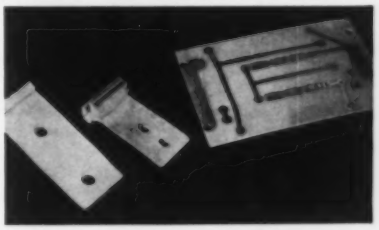


NEW ELECTRONIC FILM SPLICER RELIES ON SILICONE DIELECTRICS

Today, versatile silicone dielectrics are giving a big assist to designers of modern electronic devices. The reason: exceptional thermal and dimensional stability. These unique properties are especially apparent in a new electronic film splicer developed by Shepard Laboratories, Inc. of Summit, N. J.

Eliminating adhesives entirely, the new Shepard unit splices film with a shot of dielectric heat so quick and intense that the ends of the film fuse before they have a chance to "burn." A printed circuit etched on a copper-clad silicone-glass laminate controls the current and gives split-second timing.

Glass laminates bonded with Dow Corning silicone resins have proven ideal for printed circuits because they retain excellent dimensional stability and a high order of moisture resistance despite elevated operating temperatures.



Shepard Laboratories' electronic film splicer also uses a silicone-glass laminate for the two clamps that hold the film in position. Free from dielectric loss, and offering maximum resistance to carbon-arcing, these laminated pieces do not interfere with the passage of high frequency splicing current. Although the new splicers were designed for use

(Cont. Pg. 2)

Large Silicone Exhibit a Feature of 1958 Design Show

For the latest news of silicones and to learn how you can profitably apply silicones to your designs, be sure to visit Dow Corning's 1958 Exhibit, BOOTH 410, Chicago International Amphitheater, April 14 to 17.

While there, pick up your copy of the 1958 Guide to Dow Corning Silicones. A "must" for designers, this 16-page brochure is fact-filled with information that can help you cut costs, simplify designs and add new sales appeal to products. **No. 486**

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

Silicone News

NEW LITERATURE AND TECHNICAL DATA ON SILICONES

1958 Guide to Dow Corning Silicones—consists of 16 pages filled with data and illustrations suggesting ways in which you can cut costs, simplify designs, improve performance and add new sales appeal to your products with Dow Corning Silicones. Cross indexed for handy reference, this all-new Guide includes properties and uses for the silicone products developed in recent months. *No. 490*

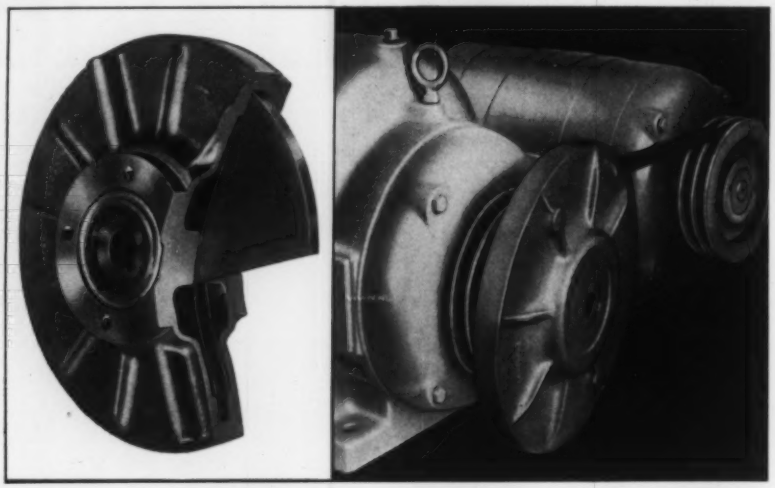
"More Muscles for Tomorrow"—A movie in color and sound gives visual proof of the benefits of silicone electrical insulation. Silicone insulation means increased production, reduced maintenance, freedom from over-motoring, and savings in space and weight. A folder describing the movie and explaining how to arrange for showings is yours on request. *No. 491*

Dow Corning Silicone Compounds, for dielectric applications, for release of plastic and rubber moldings, and for protecting finely machined thread parts, are described and compared in a handy reference pamphlet. *No. 492*

Antifoam B, the lowest priced silicone foam-killer, has greater stability than any other water dilutable silicone defoamer commercially available. Antifoam B will not separate, oil out, settle or precipitate in most applications; retains uniformity and effectiveness even under adverse storage or operating conditions. Ready to use, it requires no diluting or pre-mixing. *No. 493*

Parts and components made with Dow Corning Silicone Molding Compounds are lightweight, show excellent resistance to heat, and have good structural and electrical properties. Used as brush holders, collector rings, terminal boards, multiple lead connectors, heat dams for turbine driven alternator bearings, and aircraft brake shoe backing. *No. 494*

Silastic RTV vulcanizes at room temperature. It provides a means of using silicone rubber in those applications where a heat cure is impractical or cannot be tolerated. Available in different consistency grades, Silastic RTV retains good physical and dielectric properties. *No. 495*



FLUID COUPLINGS ATTAIN OPTIMUM PERFORMANCE WITH SILICONE FLUIDS

Dow Corning Silicone Fluids hurdle the performance barriers imposed by the limiting characteristics of organic oils. That's why they're being specified in a growing number of designs as damping or driving media. Typical example: new fluid couplings made by Electra Motors, Inc., Anaheim, Calif.

Attached to drive motors to prevent overloading and to assure smooth acceleration, Electra's fluid couplings transmit torque evenly and smoothly from a driving face to a driven disk (or vice versa) by utilizing the exceptional shear resistance and thermal stability of a Dow Corning 200 Fluid.

According to Electra, "the fluid is 50 times as constant over a wide temperature span as petroleum products of the same viscosity. This same inherent stability also applies to shear resistance."

Electra fluid couplings are compact, maintenance-free and as easy to install as ordinary sprockets. They are also featured as original equipment on a new line of Electra gearmotors ranging in size from 1/4 to 5 hp, with output speeds of 1 to 345 rpm.

Additional facts about Dow Corning 200 Fluids: (1) Serviceable from —130 to 400 F (2) Available in many viscosities (3) Show little change in damping or torque transmitting properties despite extreme temperature variations (4) Highly resistant to oxidation and to viscosity breakdown due to shear. *No. 487*

SILICONE DIELECTRICS *(Cont.)*

on the new, non-acetate movie films, they work equally well with conventional film materials.

All the Phenolite silicone-glass laminates used in this application are produced by National Vulcanized Fibre Co. *No. 488*

STRIP HEATERS *(Cont.)*

thermal conductivity allowing rapid heat transfer. Proof that Silastic does its job well in the radar recorders is the fact that over 3,000 units have been delivered to the Air Force since 1954 without a single report of unsatisfactory service. *No. 489*

Dow Corning Corporation, Dept. 683, Midland, Michigan

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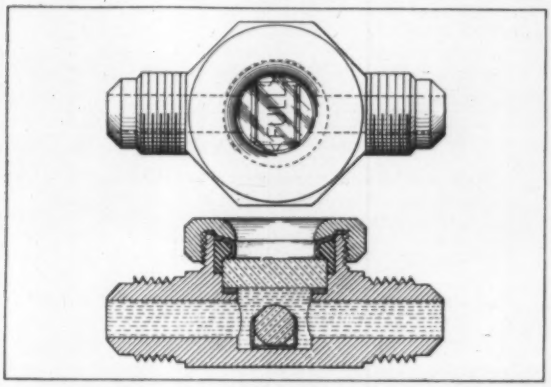
sections. Shown here in a fuel-dump-line installation for a folding aircraft wing, the unit has application wherever separable conduit sections must be sealed at a hinged joint. *Patent* 2,816,780 *assigned to Chance Vought Aircraft Inc. by Norman R. Ross.*

Liquid Indicator

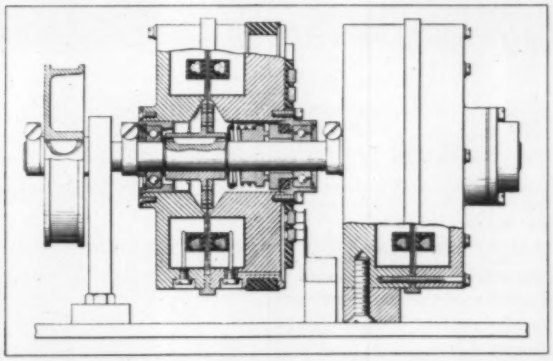
Refractive properties of an immersed cylindrical lens are cancelled out to allow FULL legend to be seen clearly when fluid flows through a liquid indicator. Legend is blurred out when no fluid is present. Optical effect is achieved by making cylindrical lens



of a material with refractive index similar to that of liquid under observation. Unit is particularly adapted for showing presence of transparent and colorless liquid. *Patent* 2,811,128 *assigned to Imperial Brass Manufacturing Co., by George E. Franck.*

High-Speed Magnetic-Powder Clutch

Extremely high acceleration and deceleration rates are permitted by a magnetic-powder clutch and brake assembly employing thin rotor discs with low inertias and large effective areas. Unit shown here, comprising identical clutch and brake units (left and right), was designed to intermittently rotate and stop a magnetic-tape capstan in acceleration and deceleration intervals of 5 to 7 milliseconds. Rotor disc, which is mounted on the drive shaft, rotates in the powder-filled clutch cavity. Clutch engages when magnetic powder is energized to couple input shaft and clutch housing. Driven pulley is integral with



specify screws with lowest lifetime cost

Here's a cost-saving tip — don't specify or buy screws on first cost alone. Evaluate the lifetime cost—it can mean substantial cost savings.

For applications requiring utmost strength and dependability, Mac-it Socket Screws have the lowest lifetime cost. This can save you money through:

LESS DOWNTIME—production interruptions from screw failures are expensive. Screw costs are negligible when compared to the costs of (1) lost production, (2) idle operators, (3) repair crews, (4) replacement parts and (5) delayed shipments.

FEWER REPLACEMENTS—because of Mac-it's longer life.

BETTER PERFORMANCE—because of Mac-it's greater resistance to punishment.

GREATER SAFETY— because of Mac-it's resistance to failure.

For screws that cost less in the long run, specify Mac-it—for original equipment and replacement parts. You will find the complete line of Mac-it Hex Socket and Alloy Cap & Set Screws at your local Mac-it distributor, or write: Mac-it Screw Division, Strong, Carlisle & Hammond, 1392 West 3rd Street, Cleveland 13, Ohio.

MAC-IT hex socket / alloy cap & set → **SCREWS**

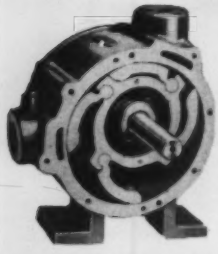
See us at Design Engineering Show, Booth 479
ASTE Show, Booth 404

Circle 545 on Page 19

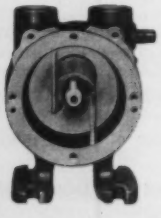
VACUUM PROBLEM?

LEIMAN
HAS THE ANSWER!

- Over 70 years' experience
- Wide range of types, sizes, models
- Engineering representatives in all industrial centers.



4-WING TYPE. Vacuums to 20" Hg.; pressures to 15 psig.; volume to 162 cfm. Cast iron wings, hinged to pistons, maintain continuous sealed contact with the cast iron cylinder walls by centrifugal force.



2-WING TYPE Vacuums to 29.9" Hg.; pressures to 20 psig.; volume to 40.8 cfm. Automatic wing adjuster forces wear-resistant steel wings to cast iron cylinder walls, preventing sticking or binding, maintaining positive vacuum or pressure.

- **Consult Leiman engineers on any vacuum application**
- **Install Leiman Vacuum Pumps for "lifetime" dependability**

Vacuum operations are usually critical, requiring a steady, reliable source of rated vacuum. You get this with Leiman Rotary Vacuum Pumps because they are designed to take up their own wear. They have fewer moving parts—and all parts are precision-made of durable cast iron and steel (not composition) to maintain new pump efficiency for 10, 15 and 20 years, without maintenance except oiling.

High vacuum, high volume, small space

The simplified Leiman design provides larger air space, permitting use of smaller pumps, slower speeds, less horsepower. Operation is quiet.

Every pump tested!

Each individual Leiman Vacuum Pump is given a long test run before shipment to assure fully rated vacuum, pressure and c.f.m. capacity.

Over half a million Leiman Vacuum Pumps have been installed with utmost satisfaction. Design Leiman dependability into *your* equipment.

WRITE for 16-page catalog, plus Application Book showing many "how-to-do-it" blueprints.

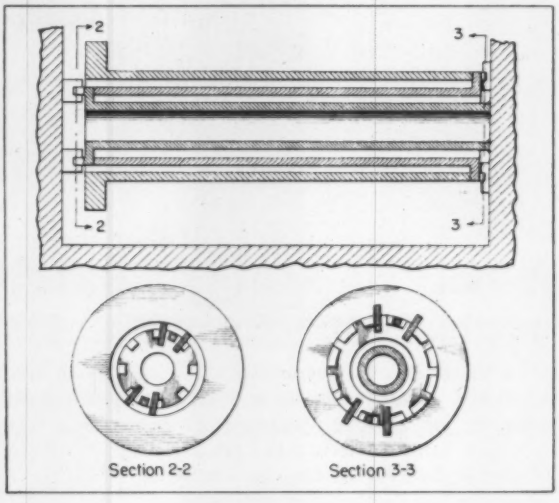
LEIMAN BROS., Inc. 158 Christie St., Newark 5, N. J.
Established 1887

LEIMAN Rotary Air and VACUUM PUMPS

clutch housing; brake housing is fixed to mounting structure. *Patent* 2,813,605 *assigned to International Business Machines Corp., New York, N. Y. by Walter S. Buslik, and Emil M. Valehrach.*

Nested-Cylinder Torsion Spring

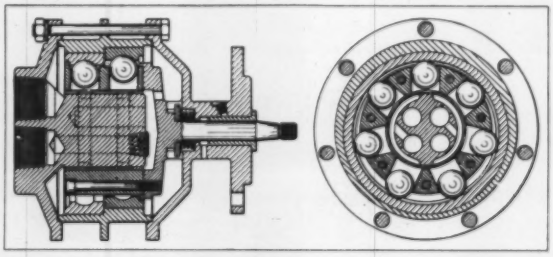
Reduced axial length, minimum stress, and simplified heat treatment of spring elements are design advantages of a nested-cylinder torsion spring. Mechanical limit stops control deflection of individual tubes, yet allow total deflection of the unit to



reach large values without overstressing the initially deflected cylinders. Variable spring rate can be provided by selecting low rates for initially deflected cylinders, higher rates for subsequent cylinders in the nest. *Patent* 2,811,347 *assigned to Thompson Products Inc., Cleveland, Ohio by Richard Cass.*

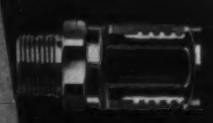
Ball-Type Pump

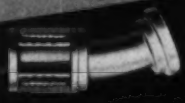
Orbiting of balls in an eccentric, stationary race gives continuous, low-leakage pumping action in a compact ball-type pump. As balls orbit about the pump axis, they perform radial pumping strokes in

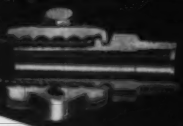


honed ball-cage cylinders. Diametrically opposed eccentricity of the two ball-cages insures dynamic balance of the assembly about the central, nonrotating pintle valve. *Patent* 2,813,492 *assigned to American Bosch Arma Corp. by Martin J. Berlyn.*

This Inside Story—
why ANCHOR®
HOSE ASSEMBLIES
Meet Your Most Rigid Requirements







The "inside story" refers first to the cross-sections shown from which the advantages of Anchor Hydraulic Hose Assemblies can be learned.

But, beyond these obvious benefits, we refer to the intangible advantages evolving from the years of experience in production of hydraulic hose assemblies—advantages that show up only in bonus months of dependable service.

Anchor Hydraulic Hose Assemblies are made for high, medium and low pressure service and for use on virtually any equipment using a hydraulic system. Working pressures range from 100 PSI (2" I.D. Spiral Wire Hose) to 7000 PSI (¼" I.D. 3 Wire Braid Hose) and a variety of coupling styles are available.

Write for Anchor Catalog No. 57S with specifications on Anchor's very complete line of hose assemblies.

ANCHOR COUPLING CO. INC.

328 North Fourth Street, Libertyville, Illinois
Branch Offices: Dallas, Tex., Plymouth, Mich.

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NEW HIGH SPEED ADJUSTABLE CLOSURES,
IN A WIDE VARIETY OF SIZES AND SHAPES, CUT PRODUCTION TIME AND COSTS!

Snap-Tite® or Turn-Tite®

Cam or Lever Action Test Plugs and Seals designed for high production use!

Snap-Tite types for use during processing of machine parts, tubes, molds, castings, tanks and for testing low pressure applications. *Turn-Tite* types for higher pressure applications. Also where restricted clearance prohibits cam action closure. Also types to accommodate pressure line connector. Snap-Tite and Turn-Tite also used as permanent parts of finished products.

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Industrial Series 1000—External ring

Industrial Series 2000—External ring

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REVOLUTIONARY COMPACT DESIGN for limited space DASH POTS...Up to 150,000 INCH LBS. ABSORPTION

PATENTS APPLIED FOR

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It's the **TAYLOR** *Liquid Spring* **SHOK*!**

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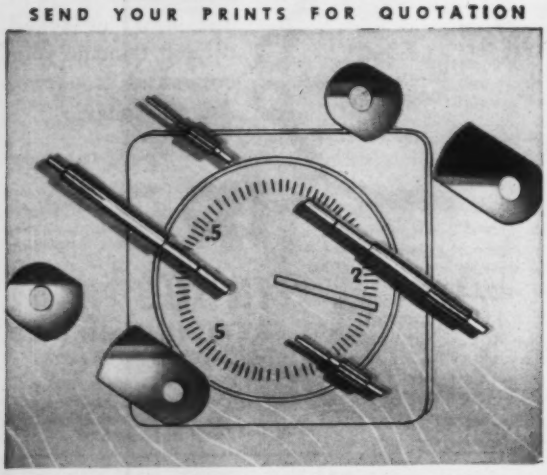

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LEPEL Electronic Tube GENERATORS—1 KW; 2½ KW, 5 KW; 10 KW; 20 KW; 30 KW; 50 KW; 75 KW; 100 KW.

LEPEL Spark Gap Converters 2 KW; 4 KW; 7½ KW; 15 KW; 30 KW.

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flexible couplings with ZERO BACKLASH

Series #1
Actual Size

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- meet JAN-MIL specs

For exacting requirements, you're sure of best results with precision-made Renbrandt Flexible Servo-Couplings. They have zero backlash and low inertia . . . and they do not introduce velocity variations between driving and driven shafts. Available in a variety of sizes for 1/16" through ½" shafts in all combinations. Widely used for servo-mechanisms, computers, and for all precision applications.

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Low cost for general application. Thousands of uses. ¼" dia. x 11/16" long. For ¼" and/or 3/16" shafts. No backlash. Insulated

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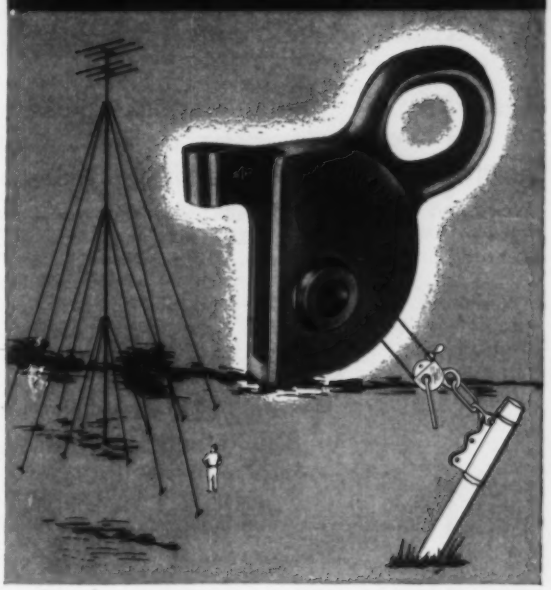
WHEN INVESTMENT CASTING FAILED

ATLANTIC CASTING *Proved Itself Again!*



When Vulcan Steel developed a device to snub steel guy cables quickly and efficiently, the Military was interested. *BUT* could "Snubit" take it?

The answer hung on the strength of a single manganese bronze casting. Pull tests were run on castings produced by the investment casting process, as well as on those produced by Atlantic's plaster mold method, under identical conditions.

The Results?

INVESTMENT-CAST UNITS FAILED AT LESS THAN 2000 POUNDS. (DIRECT PULL)

ATLANTIC-CAST UNITS WITHSTOOD MORE THAN 8000 LBS. (DIRECT PULL)

Thanks to Atlantic Casting, Military requirements were more than satisfied and the Vulcan Steel Products Company Inc. **saved 50% in casting cost.**

Send now for Atlantic's new casting catalog and see how precision casting the Atlantic way can improve your product and materially reduce costs.

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CASTING and ENGINEERING CORP.
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For "fixed" fastenings or "hard-to-reach" assemblies

USE GRIPCO CLINCH NUTS

WITH THE EXCLUSIVE HEX ON HEX FEATURE

For positive attaching of a threaded medium to thin metals. They are clinched solid for a rigid application, or staked in with a six point staking punch for a floating effect. This takes care of misalignment and creates an easier application of the bolt. Gripco Clinch Nuts can be clinched or staked with hydraulic or air equipment. Full details available — write for samples and data sheet today.

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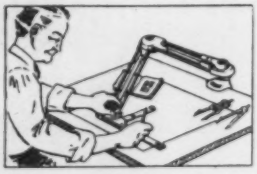
Before



After

The VEMCO Drafting Machine combines all the working features of a T-square, protractor, and various scales and triangles

Speed and efficiency are lost in the shuffle, when you have to fuss and fumble over a drawing board that's cluttered up with equipment. The modern solution to that is the VEMCO Drafting Machine, which combines the working features of several pieces of drafting equipment. See your VEMCO dealer, and you'll see what a happy difference the VEMCO Drafting Machine can make in your work.

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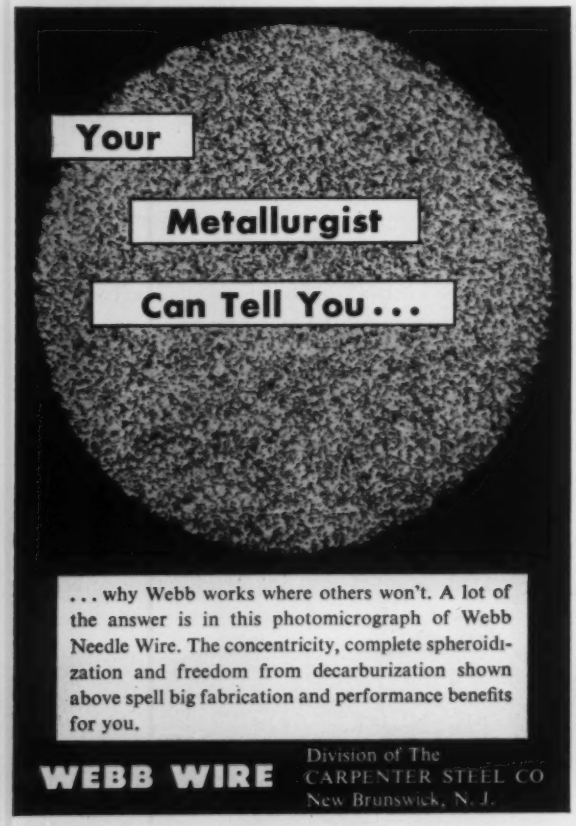

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Precision engineered — low cost!

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THE HAN-DEE SPRING & MANUFACTURING COMPANY

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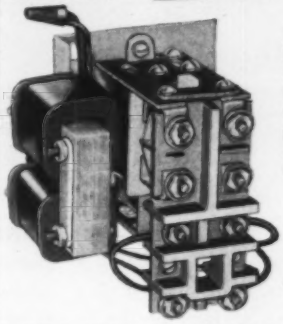
WARRICK Floatless Electrode Type LIQUID LEVEL CONTROLS . . .

give you all these advantages!



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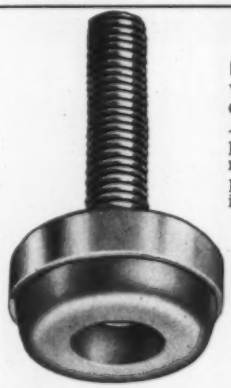
OHIO ADJUSTING SCREWS



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WITH NON-MARKING GRAY NEOPRENE PAD
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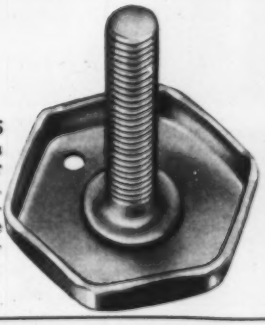
Thread sizes ¼-20 to ½-13



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Large hex head gives broad cupped base for easy hand adjustment. Used extensively on appliances as adjustable feet and as hand adjusting screws.
Thread sizes ¼-20 to ½-13

OVER 50 YEARS OF BETTER FASTENING
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Got a tough work-holding job that's bothering you . . . one which needs quick-acting and powerful clamping?

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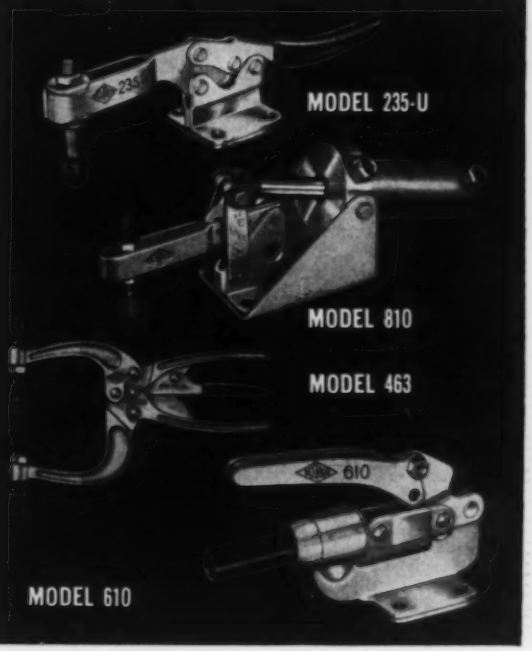
DE-STA-CO 4 TYPICAL CLAMPS



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Manufacturer of America's FIRST Line of TOGGLE CLAMPS
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THY... DE-STA-CO **TOGGLE CLAMPS**

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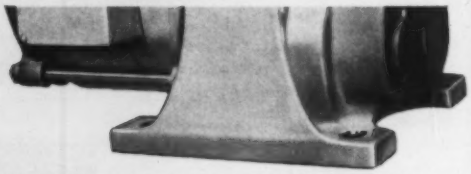
WHAT!! OUR NET COST FOR GEAR MOTORS CUT IN HALF?

Right, with our new line of Gear Motors you actually save up to 50% of your present *net* cost for gear motors. Increase your *profits* this year with our rugged, dependable line of gear motors. Call or wire collect today for the low prices and complete details.



220/440 volt—60 cycle 3 phase 1800 RPM Drip proof or totally enclosed fan cooled Ball bearing—Parallel shaft

HP	OUTPUT SPEED
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1½	39—45—56—68—84—96—125—155—190
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Also available:

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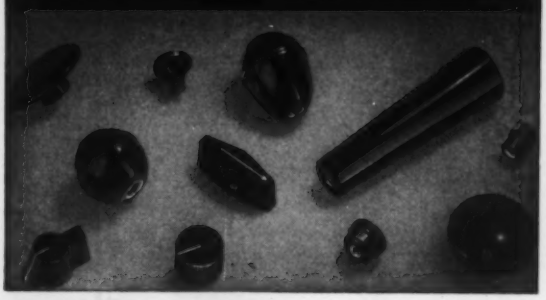

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DIMCO-GRAY COMPANY

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Circle 567 on Page 19

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to better serve your fastener requirements

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NATIONAL LOCK COMPANY
FASTENER DIVISION
Rockford, Illinois

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- MAINTAINS CONSTANT COOLING EFFICIENCY

Mounting: 2½" across flats

NEW IMPROVED HIGH SLIP MOTORS DRIVE COOLING FANS AT VARYING ALTITUDES

New, improved, high-speed, high-slip motor design changes speed with lower densities (higher altitudes) to maintain constant cooling efficiency. These high-slip motors are rated at a minimum of 1,000 hrs. at 125° C.; longer life expectancy at lower ambients. Choice of 400 cycles or Variable, 1ø, or 400 cycles, 3ø. Prototypes delivered in 2-6 weeks; Production deliveries 6-8 wks. Circle card for data sheets and performance curves.

145 CFM at O"SP
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at 70,000 ft.

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The Higher The Bearing Pressures —*The More You Need Molykote*®

Some of the highest bearing pressures are encountered in threaded connections. MOLYKOTE Lubricants perform amazingly well in preventing metal-to-metal contact under these severe conditions.

With MOLYKOTE Lubricants the coefficient of friction decreases as bearing pressures increase. The useful pressure range of these lubricants exceeds the yield point of any metal and, in terms of work load, MOLYKOTE is the cheapest lubricant you can buy.

Write today for our new catalog called "BREAKING LUBRICATION BARRIERS" (Bulletin 110). The Alpha-Molykote Corporation, 65 Harvard Avenue, Stamford, Connecticut.

MOLYKOTE© LUBRICANTS

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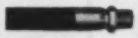
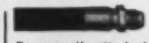
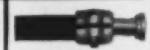
EASTMAN FLUID POWER LINES

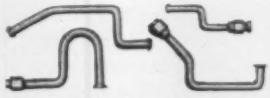
EASTMAN HIGH PRESSURE LEADERS
All available in sizes from ¼" thru 2"
375—5000 PSI working pressures.


Permanently attached Male. (NPTF) for 1, 2, & 3 wire braid hose—also 4 spiral wire.


Permanently attached Male Flare (JIC) for 1, 2, & 3 wire braid rubber cover hose.

Reusable Swivel Female for rubber or cotton cover hose. Full line available.


Clamp Coupling with Split Flange Stems for 1 & 2 wire braid rubber cover hose.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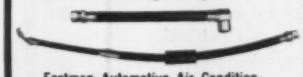
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Circle 572 on Page 19

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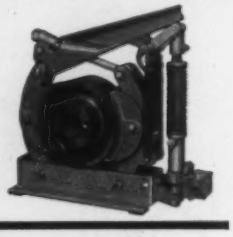

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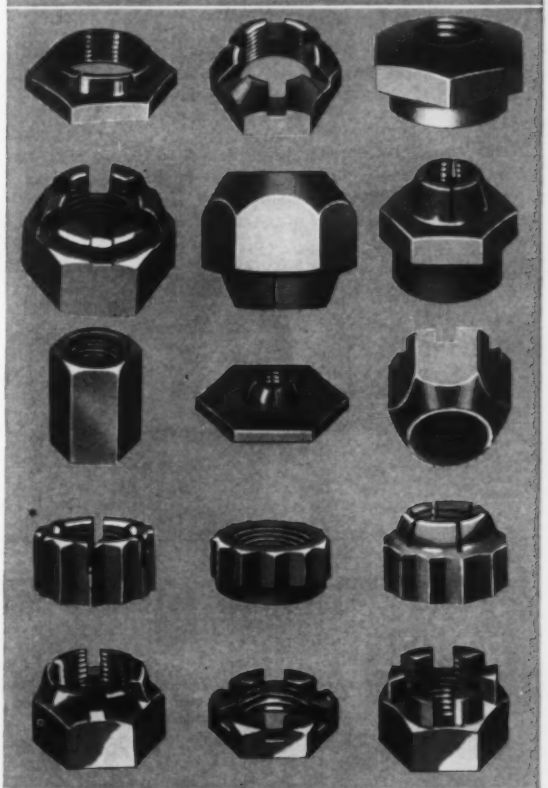

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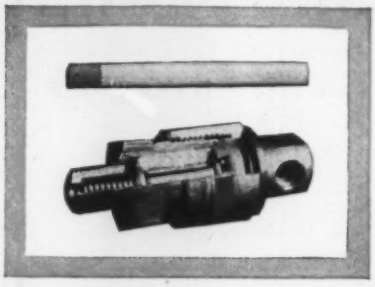

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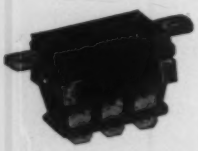

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Can specialized business publication advertising actually sell?

By reputation, salesmen are reluctant to credit anything but their own selling efforts for getting names on the dotted line.

Actually, it's quite a different story. The most successful salesmen will tell you two important things about selling. 1. That the selling process is largely a matter of communicating ideas. 2. And that specialized business publication advertising can help importantly to register information with prospects.

Of course each salesman will express this in his own way... but they all agree that selling would be far more difficult without the advertising that appears in the industrial, trade and professional publications that serve the specialized markets to which they sell.

Here, for instance, is what a salesman has to say about this kind of advertising:

Fred Snyder, Cleveland District
Worthington Corporation

sells to industry

Says Mr. Snyder:

"We have, of course, sales leads from our business paper advertising that are forwarded to us on a monthly basis. But also the trade advertising has its impact on many who do not at the time request specific information. Worthington is far better known today than it was five years ago, due in no small measure to the aggressiveness of its advertising and sales promotion department.

"Their work makes my job easier. First of all, we have an entree in companies where some Worthington products were not previously as well-known as our original line. We're getting a lot better sales coverage on all products. The Corporation manufactures so many products today that even regular customers may be unfamiliar with some of these products. Through trade advertising and sales promotion we have been able to sell the whole Worthington line.

"Getting back to sales leads—they are particularly helpful to our dealers. In Cleveland, W. M. Patterson Supply will undoubtedly receive inquiries from Worthington's advertising. Scott-Tarbell, Inc., Cleveland Oak Belting, or other dealers handling special product lines will pick up leads from our advertising to help them get business.

"I think we've grown eightfold since the war. This year we hit two hundred million. It used to be that twenty-five million was a good year. The advertising and sales promotion department has aggressively been attacking their part of the problem within the last five years. Prior to that the name Worthington was not nearly so well-known and we put much less emphasis on advertising."

Ask your own salesmen what your company's business publication advertising does for them. If their answers are generally favorable you can be sure that your business publication advertising is really helping them sell. If too many answers are negative it could well pay you to review your advertising objectives—and to make sure the publications that carry your advertising are read by the men who must be sold.

How salesmen use their companies' advertising to get more business

Here's a useful and effective package of ideas for the sales manager, advertising manager or agency man who would like to get more horsepower out of his advertising. Send for a free copy of the pocket size booklet entitled, "How Salesmen Use Advertising in Their Selling," which reports the successful methods employed by eleven salesmen who tell how they get more value out of their companies' advertising.

You'll find represented many interesting variations in how they do this. Some are very ingenious; all are effective. You can be sure that more of your salesmen will use your advertising after they read how others get business through these simple methods.

The coupon is for your convenience in sending for your free copy. Then, if you decide you want to provide your salesmen with additional copies, they are available from NBP Headquarters in Washington, at twenty-five cents each. Or, if you choose you can reprint the material yourself and distribute it as widely as you please. But first, send for your free copy.

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... each of which serves a specialized market in a specific industry, trade or profession.

why it pays to depend

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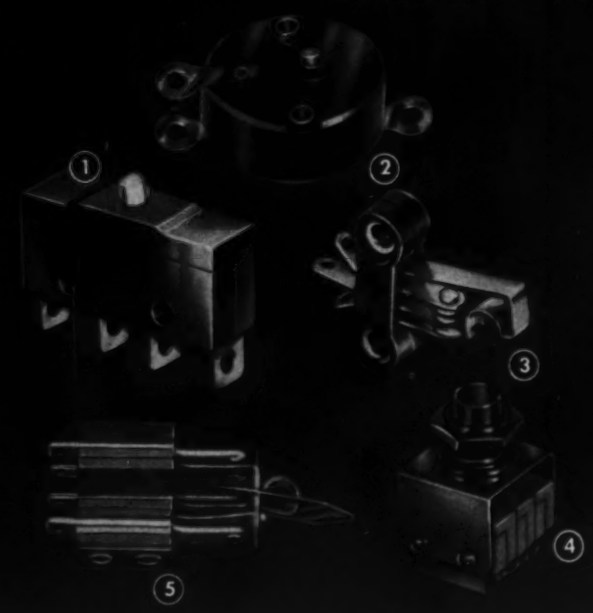


1 STANDARD SUBMINIATURE

High capacity—over four times that of most switches its size. Rated at 10 amps at 125 or 250 volts A.C. or 28 volts D.C. Wide range of newly designed actuators . . . or can be adapted to present actuators and mountings. Operating temperature range: —80° to +350°F. Terminal arrangement permits wiring double circuits.

2 NEW TYPE Q SUBMINIATURE

Smallest snap-action switch with a 10 amp—115 volt capacity. Designed for extra vibration resistance and easy installation. Adaptable to automation techniques. Ruggedly built to take up to 100,000 operations at capacity load. Meets a variety of circuit requirements.

3 OPEN BLADE SUBMINIATURE

Use your own housing—even include other components if you desire—with this unique precision switch. Readily adapts to return or set type operation. Actuator may be insulated or extended to meet requirements. Many other combinations are possible.

4 PUSH BUTTON SUBMINIATURE

Three split contact circuits in subminiature size. Only 25/32" long by 55/64" wide by 1 13/64" high. Rated at 10 amps—115 volts A.C. This panel mounted, overtravel plunger-type actuator assembly is believed to be the smallest yet made.

5 OPEN BLADE MULTI-POLE SUBMINIATURE

Recommended for economical and positive control of two circuits. Laminations are secured by two eyelets which provide holes for mounting screws. Available in return or set type with rear or side terminals.

ACRO Subminiature Switches

Compare the ACRO group of Subminiature Switches any way you like—cost, performance, size, capacity, versatility—you'll see why more and more design engineers are specifying ACRO.

These five basic types of subminiature switches offer many development possibilities for your subminiature assemblies . . . from aircraft applications to vending machines. All incorporate the patented rolling spring action for which ACRO Switches are internationally known and respected.

ACRO's modern mass-production techniques and facilities assure lowest possible unit cost . . . even when variations of basic switches are required to meet your specific needs.

Talk over your requirements or possibilities with an ACRO engineer . . . or write for engineering data on any or all of the five subminiature switches shown here.

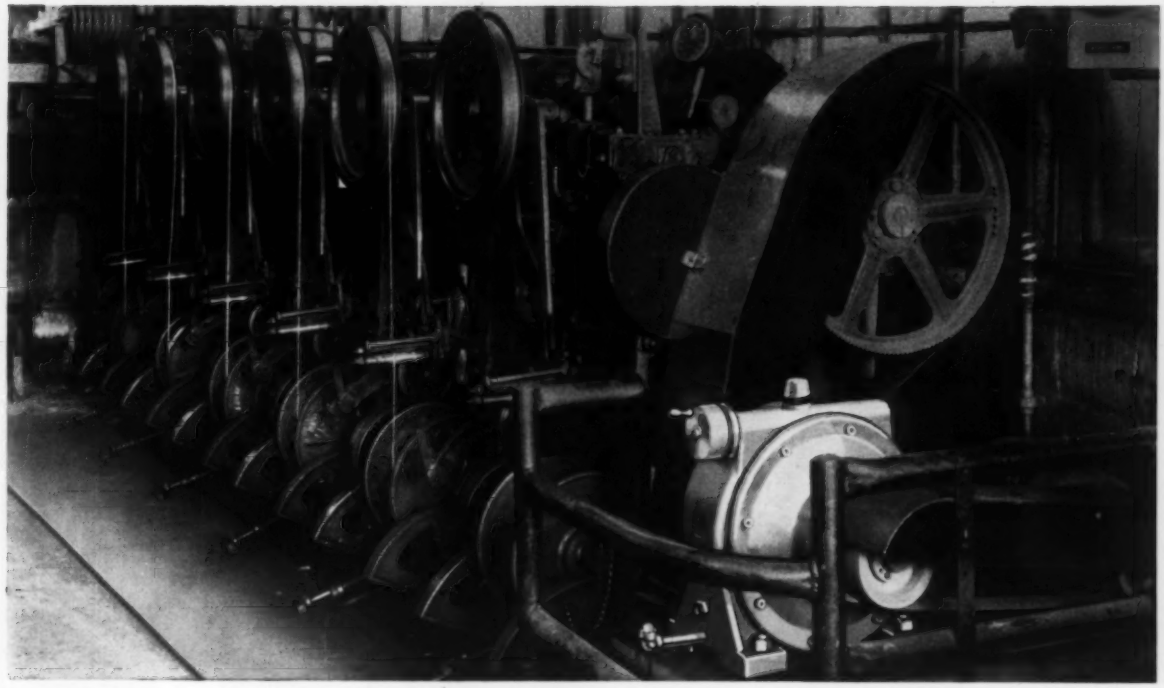
Mr. Controls®

Robertshaw-Fulton CONTROLS COMPANY

ACRO DIVISION Dept. 133, Columbus 16, Ohio

In Canada: Robertshaw-Fulton Controls (Canada) Ltd., Toronto

Circle 583 on Page 19



CLEVELAND SPEED VARIATOR

winds 4 reels of cable simultaneously—where old drive slipped with 2 reels

THIS machine winds tin-plated wire used in the manufacture of cable. The Cleveland Speed Variator on it replaced a drive of the same capacity with which there was slippage and frequent maintenance.

With the new Cleveland, it was immediately possible to run simultaneously 5 reels of the heaviest wires, as compared to only 2 with the old drive. In fact, the 10 HP drive motor soon proved unequal to the 5-reel load which the Cleveland was handling without slippage. Now driving 4 reels of the heavy wire, the machine is doing double the work it formerly handled.

Wherever you need a variable speed drive, consider Cleveland. Write for Bulletin K-200. The Cleveland Worm & Gear Company, Speed Variator Division, 3287 East 80th Street, Cleveland 4, Ohio.

Note these major advantages of the Cleveland Speed Variator

1 An extremely compact unit, with input and output shafts in line and rotating in the same direction.

2 Operable at any input speed up to 1800 rpm—either clockwise or counterclockwise rotation.

3 Rated for constant horsepower output over a 9:1 or 6:1 range; or for constant torque over a 6:1 range.

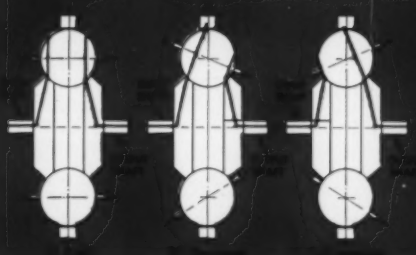
4 Infinitely variable output speeds over the entire range of adjustment.

5 No slippage—positive, automatic torque adjustment in direct proportion to the loads encountered.

6 Ample bearing support on both shafts for overhung pulleys.

7 Long life and minimum maintenance through absence of belts and complicated linkages.

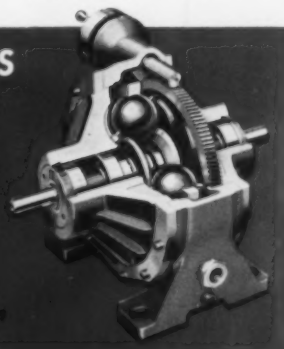
HOW THE CLEVELAND SPEED VARIATOR WORKS



Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts.

Relative speeds of the shafts are adjusted by changing the positioning of axles on which the balls rotate (diagram, right, shows cutaway Variator with hand regulating wheel).

"It's the Drive That's on the Ball."



Circle 402 on Page 19

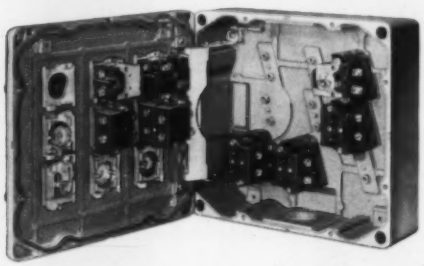
The world's finest machines are controlled from Cutler-Hammer oil-tight pushbutton Control Stations

The Cutler-Hammer line of heavy duty oil-tight pushbuttons and precision die-cast control stations surpass anything ever before available to serve the needs of machine design engineers. Cutler-Hammer Oil-Tight Control Stations are precision die-castings to permit both base and one-hole mounting of the control units. The one to four element control stations are available in either the normal depth or the exclusive shallow depth for use where space limitations are critical.

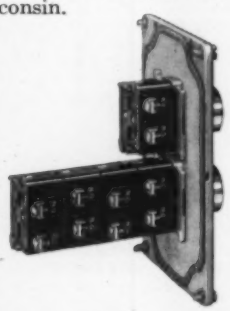
Cutler-Hammer Pushbutton contact blocks are easily tandem mounted without special adapters, and use less behind-the-panel space than any other. Circuits can be arranged in any combination of NO and NC contacts.

Indicating lights come in a wide selection of colors with either plastic or glass lenses. Among the many special operators are: Roto-Push®, the combination pushbutton-selector switch; PresTest®, the self-testing indicating light; knob, key, lever, and coin type selector switches; flush, long, mushroom head, guarded, and palm type pushbutton operators.

Write today on your company letterhead for the illustrated booklet EL-178, Master Design. CUTLER-HAMMER Inc., 1310 St. Paul Avenue, Milwaukee 1, Wisconsin.

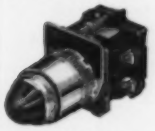


The hinged cover on the larger Oil-Tight Control Stations facilitates assembly and alterations. Precision die-castings permit both base and one-hole mounting of the control units. Raised edge on the box mates with the neoprene-cork cover gasket for a perfect seal.



Complete line of cover plates for cavity mounting. Compact contact blocks take 40% less space behind the panel than the next smaller element . . . additional blocks easily tandem mounted . . . from 2 to 8 separate circuits in any combination of NO or NC contacts.

Special Purpose Operators and Accessories



PresTest—the self-testing indicating light

Guarded mushroom head operator

Neoprene protective boot for flush or long button operators

Indicating lights, six colors available with plastic or glass lenses

Roto-Push—the one button control station . . . with or without lever ring in a deep precision die-cast enclosure

Selector switches—knob, lever, key, coin

CUTLER·HAMMER
MOTOR CONTROL
C·H

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